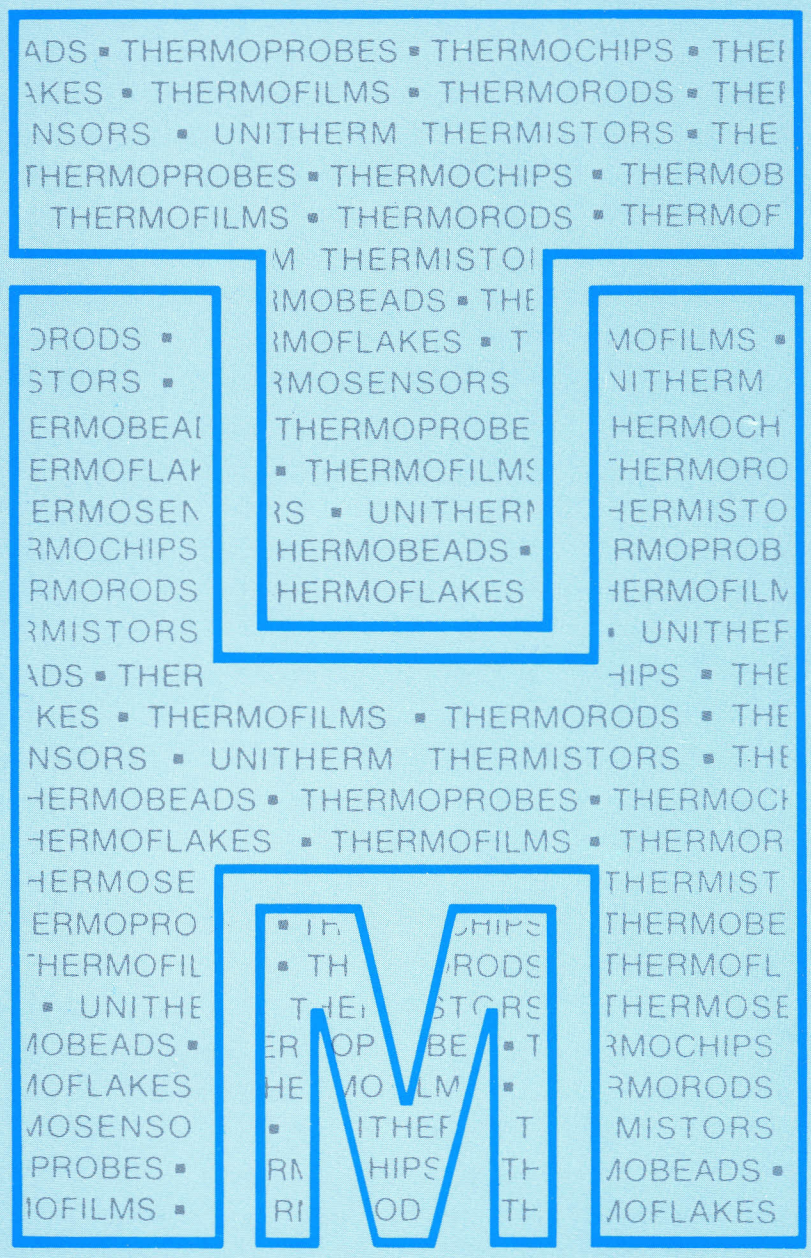
THERMISTORS

THERMOCOUPLES

PRESSURE SENSORS



THERMOMETRICS INC.

The Source of Thermistor Expertise

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Catalog No. 183

Thermometrics... The Source of Thermistor Expertise

THERMOMETRICS has established a position in the electronics and general technical community as "THE SOURCE OF THERMISTOR EXPERTISE." Our reputation for the HIGHEST QUALITY products at low, competitive prices continues as an axiom of our business posture.

Our continuous R&D efforts have pioneered many noteworthy developments. Some are: The first precision Thermistor Standard, called the Series S-10; the Series SP-1 ultra-stable thermistors; a high temperature series for use above 450°C; the Fastip Thermoprobes which offer response times of 7 milliseconds; the Unitherm interchangeable thermistor line; the Series BR ruggedized beads for high reliability sensor assembly operations; special process Medical Catheter Thermistors; the A919a Fluid Temperature Sensors; and Precision Temperature Calibration to .0015°C.

The Thermometrics engineering staff routinely (and graciously) offers applications assistance. From a one time experiment to a large volume OEM requirement, you will find us interested and informed with imaginative thermistor expertise at your disposal. Your new ideas and requirements are welcome challenges for us at Thermometrics to continue to advance the thermistor State-of-the-Art even further in the future.

This Thermistor Handbook is designed to offer our customers a comprehensive range of thermistor types to suit every purpose. Every attempt has been made to organize this book to serve you rapidly and accurately. The "THERMISTOR SELECTION GUIDE" located at the front of this book will give you a broad overview of our standard thermistor lines, which are described in detail in the following chapters. If you don't see the thermistor which meets your specific requirements, we probably have the version you need listed in our nonstandard files. Please call us with any information requests, questions, or if you just want to talk about thermistors and temperature measurement.

Thermometrics, Inc., manufactures a Thermistor or Sensor Assembly to satisfy your requirements for any of the thermistor applications listed below. Please contact us for assistance in matching the proper thermistor to your application or to obtain information on new applications.

I. THERMISTOR APPLICATIONS BASED ON R-vs-T CHARACTERISTICS

(Temperature Measurement & Control)

General Industrial Applications

Industrial Process Controls
Plastic Laminating Equipment
Hot Glue Dispensing Equipment
Auto & Truck Tire Curing
Fiber Processing & Manufacturing
Pyrometers (Non-Contact)
Photographic Processing
Copy Machines
Soldering Irons (Controlled)
Hot Mold Equipment (Thermoplastics)
Solar Energy Equipment

Consumer Appliances and Household Applications

Thermostats
Small Appliance Controls
Burglar Alarm Detectors
Oven Temperature Control
Refrigeration & Air Conditioning Equipment
Fire Detection

Medical Applications

Fever Thermometers
Dialysis Equipment
Rectal Temperature Monitoring
Myocardial Probes
Esophageal Tubes
Skin & Muscle Temperature
Thermodilution Catheters
Respiration Rate Measurement
Blood Analysis Equipment
Respirators
Hypodermic Needle Probes
Fluid Temperature

Instrumentation Applications (Compensation)

Motor Winding Temperature Compensation
Infrared Sensing Temperature Compensation
Instrument Winding Temperature Compensation

Automotive and Transportation Applications

Emission Controls
Differential Temperature Controls
Fire Protection and Safety Equipment
Engine Temperatures
Aircraft Temperatures
Rotor/Bearing Temperatures

Laboratory & Scientific Applications

Temperature Standards
Chemical Analysis
Oceanographic Research
Meteorology
Bathythermography
Calorimetry
Titration Studies
Geological Temperature Studies
Spectrophotometers
Bolometry
Osmometers

Food Handling Applications

Fast Food Processing
Perishable Shipping
Oven Temperature Control
Food Storage
Coffee Makers
Freezing Point Studies

High Reliability and Military Applications

Missiles & Spacecraft Temperatures
Aircraft Temperatures
Submarines & Underwater Monitoring
Fire Control Equipment

Communications Applications

Transistor Temperature Compensation
Gain Stabilization
Piezo Electric Temperature Compensation
Ambient Temperature Compensation

II. THERMISTOR APPLICATIONS BASED ON E-vs-I CHARACTERISTICS

General Industrial Applications

Liquid Level Control
Voltage Regulation
Anemometers
Power Indicators
Gas Chromatography Equipment
Microwave Power Measurement
Flow Sensing Equipment
Vacuum Manometers
Overload Protection
Gas Detection
Amplifier Gain or Level Stabilization

III. THERMISTOR APPLICATIONS BASED ON CURRENT-vs-TIME CHARACTERISTICS

Time Delay Devices
Sequential Switching
Surge Suppression

THERMISTOR SELECTION GUIDE

N.T.C. THERMISTORS (ALL THERMISTORS IN THIS CATALOG ARE NEGATIVE TEMPERATURE COEFFICIENT)

Page	Series	Thermistor Type	Dimensions		Lead Diameter	Minimum Lead Length	Lead Material	Maximum Power Rating (Watts)	Maximum Continuous Temperature (°C)	Resistance Range @ 25°C (ohms)	Applications	Time Constant: still air (seconds)	Time Constant: water plunge (milliseconds)	Dissipation Constant: still air (milliwatts per °C)	Dissipation Constant: still water (milliwatts per °C)
THERMOFLAKES			**Thickness**	**Size**											
D-1	1F	Flake thermistors (with leads)	0.001"	.020" x .020" to .120" x .120"	.0007" to .001"	¼"	Pt Alloy	.030	105° C	50K-2M	Fast response, limited temperature range. Used in infrared detection, non-contact temperature sensing, intruder alarms, general purpose temperature measurement and control. For mounting in hybrid microcircuits, temperature control and compensation.	0.065	—	.30	—
D-1	2F		0.002"			¼"	Pt Alloy	.035	105° C	50K-2M		0.075	—	.50	—
D-5	FM	Microcircuit Flake thermistors	*	*	*	*	Pt Alloy	.050	105° C	1K-1M		0.125	—	.50	—
HIGH TEMPERATURE THERMOBEADS & THERMOPROBES			**Maximum Diameter**	**Length**						**Resistance Range @ 125°C**					
E-1	HTBR55	Hi-Temp Beads	0.060"	—	0.004"	5/16"	Pt Alloy	.040	450° C	100K to 2M	The only thermistor available for continuous operation with good stability above 300°C. Used in high temperature measurement and control such as oven temperature monitoring and control, soldering station control. They have an improved range and better stability at high temperatures than conventional thermistors.	7	—	.50	—
E-3	HTP60	Hi-Temp Probe Thermistors	0.060"	¼-½"	0.008"	½"	Pt Alloy	.060	450° C	100K to 2M	Probes exhibit better stability and are used in larger assemblies.	12	—	.60	—
E-3	HTP65		0.065"	¼-½"	0.008"	½"	Pt Alloy	.065	450° C	100K to 2M		13	—	.65	—
E-3	HTP85		0.085"	¼-½"	0.008"	½"	Pt Alloy	.075	450° C	100K to 2M		16	—	.80	—
E-3	HTP100		0.100"	¼-½"	0.008"	½"	Pt Alloy	.100	450° C	100K to 2M		22	—	1.0	—
FASTIP THERMOPROBES										**Resistance Range @ 25°C**					
F-1	FP07	Fast Response Probe Thermistors	0.085"	½"	0.012"	⅞"	Tinned Dumet	.006	300° C	1K to 10M	Small bead thermistor sealed at the tip of a glass probe. They feature the ultra-fast-response times of small beads in a more easily handled package. High speed temperature measurement and control, as well as bathythermography, flow measurement and control.	.10	7	.05	.25
F-1	FP10		0.085"	½"	0.012"	⅞"		.010	300° C	1K to 10M		.12	10	.09	.45
F-1	FP14		0.085"	½"	0.012"	⅞"		.014	300° C	1K to 10M		.15	16	.10	.50
CRYOGENIC THERMOPROBES										**Resistance Range @ 196°C**					
G-1	CTP60	Cryogenic Probe Thermistors	0.060"	⅛-½"	0.008"	⅞"	Tinned Dumet	.060	125° C	100K to 1M	For very low temperature measurement and control. Cryogenic liquid level and flow measurement. Ruggedized, high stability. Calibration available. Use to - 196 C	12	—	.60	—
G-1	CTP65		0.065"	⅛-½"	0.008"	⅞"		.065	125° C	100K to 1M		13	—	.65	—
G-1	CTP85		0.085"	⅛-½"	0.012"	⅞"		.075	125° C	100K to 1M		16	—	.80	—
G-1	CTP100		0.100"	⅛-½"	0.012"	⅞"		.100	125° C	100K to 1M		22	—	1.0	—
G-1	CTFP07	Cryogenic Fast Response Probe Thermistors	0.085"	½"	0.012"	⅞"		.006	125° C	100K to 1M	Ultrafast response times are the feature of these probes used in high speed cryogenic temperature measurements and control. Calibration available. Use to - 196°C.	.1	—	.05	—
G-1	CTFP10		0.085"	½"	0.012"	⅞"	Tinned Dumet	.010	125° C	100K to 1M		.12	—	.09	—
G-1	CTFP14		0.085"	½"	0.012"	⅞"		.014	125° C	100K to 1M		.15	—	.10	—
CHIP THERMISTOR															
H-1	C100	Epoxy Coated Low Cost Chips	0.100" DIA		0.012"	1½"	Tinned Copper	.075	150° C	2K to 300K	Low cost, broad tolerance chip thermistors used in high volume temperature measurement and control applications such as energy management or small appliances.	10	1 SEC (Stirred Oil)	1.0	8.0 (Stirred Oil)
HYBRID MICROCIRCUIT THERMISTOR CHIP															
H-3	HM	Hybrid Microcircuit Chips	**Thickness:** 0.010 to 0.015"	**Size:** 0.025" x 0.025" to 0.085" x 0.085"	—	—	Silver Palladium Electrodes	●	150°C	2K to 100K	Leadless bare chip thermistor for surface mounting on hybrid substrates, IC's or PCB's.	10-45 SEC●	—	7-15 mW/° C IN AIR	—
THERMISTOR DISCS															
H-5	D320 D200 D120	Thermistor Discs	0.120" to 0.320" DIA		0.020"	1"	Tinned Copper	450 to 700●●	125° C	13Ω to 400K	Lacquer or epoxy coated large discs for use in temperature compensation, time delay or current limiting applications	50 to 60 SEC●●	—	4.7 to 7.0 ●●	—
DIODE PACKAGE CHIP THERMISTORS															
H-7	DP70	Diode Package Chips	0.080" MAX DIA x .165" long		0.020"	1"	Tinned Copper	.200	300° C	10K to 100K	Chip thermistors in glass diode package for use in high volume low cost industrial or commercial applications.	25	—	2.0	—
THERMOCHIP			**Nominal Size**												
I-4	DC95F	Epoxy coated interchangeable chip	0.095" DIA		0.012	1½"	Tinned Copper	.075	105° C		Close tolerance interchangeable chips. 2252, 3000, 5000, 10000 OHMS	10	1 SEC (Stirred Oil)	1.0	8.0 (Stirred Oil)

* see page D-5 for details

● Depends upon mounting to substrate as well as size

●● Depends upon size

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THERMISTOR SELECTION GUIDE

N.T.C. THERMISTORS (ALL THERMISTORS IN THIS CATALOG ARE NEGATIVE TEMPERATURE COEFFICIENT)

Page	Series	Thermistor Type	Dimensions	Available Lengths	Lead Diameter	Minimum Lead Length	Lead Material	Maximum Power Rating (Watts)	Maximum Continuous Temperature (°C)	Resistance Range @25°C (ohms)	Applications	Time Constant still air (seconds)	Time Constant water plunge (milliseconds)	Dissipation Constant still air (milliwatts per °C)	Dissipation Constant still water (milliwatts per °C)
THERMOBEADS			**Diameter**												
B-1	BB05	Bare Bead Thermistors	0.005″		0.0007″	5/16″	Pt Alloy	.004	150° C	1K to 10M	LOW COST. Ultrafast response times. Not as stable as glass coated units. Limited temperature range. Used in catheters, microwave power measurements, hypodermic needle assemblies, general temperature measurement and control.	0.11	4.5	.05	.25
B-1	BB07		0.007″		0.001″	5/16″	Pt Alloy	.006	150° C	300 to 10M		0.2	6	.07	.35
B-1	BB11		0.011″		0.002″	5/16″	Pt Alloy	.008	150° C	300 to 10M		0.65	11	.095	.47
B-2	B05	Small Glass Coated Thermistors	0.005″		0.0007″	5/16″	Pt Alloy	.006	300° C	1K to 10M	Ultrafast response time. Good stability. Used in microwave power measurements, catheters, hypodermic needle assemblies, general temperature measurement and control, gas analysis and flow sensing.	0.12	5	.045	.23
B-2	B07		0.007″		0.0007″	5/16″	Pt Alloy	.008	300° C	1K to 10M		0.23	7	.06	.30
B-4	B10		0.010″		0.001″	5/16″	Pt Alloy	.010	300° C	300 to 10M		0.5	10	.09	.45
B-4	B14		0.014″		0.001″	5/16″	Pt Alloy	.014	300° C	300 to 10M		1.0	15	.10	.50
B-6	B35	Large Glass Coated Thermistors	0.035″		0.004″	5/16″	Pt Alloy	.035	300° C	30Ω to 20M	Fast response. Good stability. Used for general temperature compensation, measurement and control.	4.5	100	.30	1.5
B-6	B43		0.043″		0.004″	5/16″	Pt Alloy	.035	300° C	30Ω to 20M		5.5	140	.35	2.0
B-8	BR11	Ruggedized Thermistors	0.011″		0.0007″	5/16″	Pt Alloy	.007	300° C	1K to 10M	More stable than glass coated counterparts. Highly reliable and easy to handle. Offer excellent stability. Recommended for use in all of the applications listed above; particularly suitable for assembly in a wide range of sensors and housings.	0.8	12	.065	.33
B-10	BR14		0.014″		0.001″	5/16″	Pt Alloy	.015	300° C	300 to 10M		1.0	14	.10	.50
B-10	BR16		0.016″		0.001″	5/16″	Pt Alloy	.015	300° C	300 to 10M		1.2	16	.12	.60
B-12	BR23		0.023″		0.002″	5/16″	Pt Alloy	.020	300° C	300 to 10M		1.7	40	.18	.90
B-14	BR32		0.032″		0.003″	5/16″	Pt Alloy	.035	300° C	100Ω to 10M		4.5	90	.28	1.4
B-16	BR42		0.042″		0.004″	5/16″	Pt Alloy	.042	300° C	30Ω to 20M		5.0	140	.33	1.65
B-18	BR55		0.055″		0.004″	5/16″	Pt Alloy	.050	300° C	30Ω to 20M		7.0	200	.50	2.5
THERMOPROBES & THERMORODS															
C-1	P20	Small Glass Probes	0.020″	1/16-1/4″	0.001″	1/4″	Pt Alloy	.020	300° C	300 to 10M	These fast response probes have improved stability over glass beads. The longer stem length makes them easy to handle. Suitable for use in small assemblies. They are also used for fluid flow measurement, liquid level sensing and control; and general temperature and control.	1.6	18	.14	.70
C-1	P25		0.025″	1/8-1/4″	0.002″	1/4″	Pt Alloy	.025	300° C	300 to 10M		2.0	23	.16	.80
C-3	P30		0.030″	1/8-1/4″	0.003″	1/4″	Pt Alloy	.035	300° C	100 to 10M		3.0	60	.30	1.5
C-5	P60	Large Glass Probes	0.060″	1/8-1/2″	0.008″	7/8″	Tinned Dumet	.060	300° C	30Ω to 20M	Low cost units offer high reliability, fast response,tinned leads. They are rugged, easy to handle and are the most stable thermistors. Used in larger assemblies and immersion probes.	12	300	.6	3.0
C-5	P65		0.065″	1/8-1/2″	0.008″	7/8″		.065	300° C	30Ω to 20M		13	320	.65	3.3
C-5	P85		0.085″	1/8-1″	0.012″	7/8″	Tinned Dumet	.075	300° C	30Ω to 20M		16	400	.8	4.0
C-5	P100		0.100″	1/8-2″	0.012″	7/8″		.100	300° C	30Ω to 20M		22	650	1.0	5.0
C-7	R60	Bead in Glass Rods with axial leads	0.060″	1/4″ only	0.008″	7/8″	Tinned Dumet	.060	300° C	30Ω to 20M	These units have an axial lead configuration. They have the same applications as the probes listed above.	12	300	.6	3.0
C-7	R65		0.065″	1/4″ only	0.008″	7/8″		.065	300° C	30Ω to 20M		13	320	.65	3.3
C-7	R85		0.085″	1/4″ only	0.012″	7/8″	Tinned Dumet	.075	300° C	30Ω to 20M		16	400	.8	4.0
C-7	R100		0.100″	1/4″ only	0.012″	7/8″		.100	300° C	30Ω to 20M		22	650	1.0	5.0
C-9	SP60	Ultrastable probes	0.060″	1/4-1/2″	0.008″	7/8″	Tinned Dumet	.060	●	30Ω to 20M	Specially aged and processed ultrastable probes for laboratory standards, calorimetry studies, precision measurement and control. Stability Class A (To 105° C) Tinned Dumet Leads Stability Class B (To 200° C) .008 Pt. Alloy Stability Class C (To 300° C) .008 Pt. Alloy	12	300	.6	3.0
C-9	SP65		0.065″	1/4-1/2″	0.008″	7/8″		.065	●	30Ω to 20M		13	320	.65	3.3
C-9	SP85		0.085″	1/4-1/2″	0.012″	7/8″		.075	●	30Ω to 20M		16	400	.8	4.0
C-9	SP100		0.100″	1/4-1/2″	0.012″	7/8″		.100	●	30Ω to 20M		22	650	1.0	5.0

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● Depends upon Stability Class - See Page C-10

THERMISTORS

TABLE OF CONTENTS

CALIBRATION FACILITIES AND SERVICES

A complete range of resistance versus temperature calibration is available for any of the products offered for sale by Thermometrics, Inc. We are one of the few companies in the world that has the facilities and technical expertise required for the manufacture of thermistor temperature standards. Thermometrics Inc. is the only manufacturer in the world that offers a line of thermistor standards with calibration accuracy of 0.0015° C.

Temperature measurements at Thermometrics are traceable to the International Practical Temperature Scale of 1968 (IPTS-68) as maintained by the National Bureau of Standards (NBS). Traceability is achieved by means of triple point of water cells for the defining fixed point of 0.01° C (273.16K) and through the use of standard platinum resistance thermometers (SPRT) calibrated by NBS at other points. In the text of IPTS-68, the standard platinum resistance thermometer is specified as the standard interpolation instrument for realizing the scale between the defining fixed points.

The range of -140° C to +260° C is defined by fixed points at the boiling point of oxygen (-182.962° C), triple point of water (0.01° C), freezing point of tin (231.9681° C) and freezing point of zinc (419.58° C). The temperature uncertainties for calibrations at Thermometrics are 0.0002° C at the triple point of water, 0.0015° C between 0° C and 60° C, 0.003° C between 60° C and 125° C, and 0.005° C for other temperatures in the range of -140° C to 260° C.

RESISTANCE - TEMPERATURE STANDARDS

Standards maintained at Thermometrics include the following:

- Triple point of water cells (fixed point primary standard); Jarrett Instrument Co., type A.
- Standard platinum resistance thermometers (periodically calibrated by NBS): Leeds and Northrup, model 8163.
- Standard resistors, four wire (.001% accuracy, and periodically calibrated by NBS); Leeds and Northrup, models 4020-B, 4025-B, 4030-B, 4035-B, & 4040-B.
- Comparison bridge, four wire (±0.2 PPM, traceable to National Research Council of Canada, accuracy verified by NBS traceable ratio measurements on standard resistors); Guildline model 9975.
- Thermistor Standards (Calibrated against standard platinum resistance thermometer); Thermometrics, series S-10, S-15, S-20, S-25 and S-50.
- Ohmic Standard precision resistance decade (0.005% accuracy verified against 0.001% standard resistors); Vishay, model 130.
- Guarded Wheatstone Bridge (0.005% accuracy, verified against .001% standard resistors) Leeds and Northrup model 4737, (used with model 9828 Null detector).
- Constant Temperature Baths (control varies between .0002° C and .003° C depending upon temperature setting, bath fluid and use of integrating block).

SERVICES AVAILABLE:

CALIBRATION: Resistance versus temperature calibration is available at one or more temperature points within the range of -140° C to +260° C in accordance with any of the calibration schedules shown in table 1 and described as follows:

SCHEDULE 1: Available only for thermistor standards, ultrastable thermistor probes or assemblies which incorporate these devices. Calibrations are made in an integrating block submerged in a precision constant temperature bath. The bath and block temperature is established using an SPRT, resistor standards and four wire comparison bridge. Resistance measurements of the thermistors are made using a precision Wheatstone bridge verified against standard resistors and an ohmic standard precision resistance decade.

SCHEDULE 1A: Available only for thermistor standards, ultrastable thermistor probes or assemblies which incorporate these devices. The bath and block temperature is established using two or more thermistor temperature standards which have been calibrated against an SPRT. Resistance measurements are performed the same as for schedule 1.

SCHEDULE 2: Available for all glass probe thermistors or assemblies which incorporate these devices. Stability requirements with respect to temperature range and time span must be verified prior to calibration. The bath and block temperature is established using two or more thermistor temperature standards which have been calibrated against an SPRT. Resistance measurements are performed using a precision Wheatstone bridge verified against an ohmic standard resistance decade.

SCHEDULE 3: Available for all glass enclosed beads and probes as well as epoxy encapsulated discs or chips and sensor assemblies using these devices. It is advised that stability required be verified prior to calibration. A precision constant temperature bath is set using two or more thermistor temperature standards. Resistance measurements are performed using a precision Wheatstone bridge verified against an ohmic standard resistance decade.

SCHEDULE 4: Available for all thermistors and sensor assemblies. A constant temperature bath is set using two or more thermistor standards. Resistance measurements are performed using a calibrated Wheatstone bridge or digital meter, or data acquisition system.

SCHEDULE 5: Available for all thermistors and sensor assemblies. A production temperature bath is set using two or more thermistor standards. Resistance measurements are performed using a digital meter.

EQUATION CONSTANTS

Depending upon the temperature range and accuracy desired, the equations shown on page A2 of the catalog may be used to describe the resistance-temperature characteristic of a thermistor. In addition to calibration, the equation constants can be furnished for these equations.

The accuracy of equation (1) varies between .01° C and 0.1° C for temperature spans of 10° C to 30° C. Its use is not recommended over wider spans. For example, the uncertainty increases to .3° C for a 50° C span. The uncertainty of equations (2a) and (2b) is equal to the calibration uncertainty for a span of 50° C and is approximately twice the calibration uncertainty for a 100° C span. The uncertainty of equations (3a) and (3b) is equal to the calibration uncertainty for a span of 100° C and is approximately twice the calibration uncertainty for a 150° C span. When more than four calibration points are requested, the constants for equation (3a) and (3b) are obtained from a polynomial regression analysis which statistically improves the accuracy of the calibration data.

Additional information on the exactness of fit of thermistor resistance temperature data is available in Thermometrics Inc. Application Note 216.

RESISTANCE VS TEMPERATURE TABLES

In addition to calibrations and equation constants, Thermometrics can furnish computer generated tables of resistance versus temperature for any calibrated thermistor or sensor assembly. Such tables are available with temperature increments from .001° C to 1° C. Since the tables are generated from the thermistor equations, the accuracy of the tables is consistent with the equation accuracy.

TRACEABILITY DOCUMENTATION

Upon request, for a nominal fee, documentation for traceability to the National Bureau of Standards can be furnished for all calibrations performed at Thermometrics.

TABLE I

CALIBRATION SCHEDULE	RESISTANCE ACCURACY	TEMPERATURE ACCURACY (± °C) FOR RANGES SHOWN:				
		-140° C to -80° C	-80° C to 0° C	0° C to 60° C	60° C to 125° C	125° C to 260° C
1	0.005 %	.005	.003	.0015	.003	.005
1A	0.005 %		.005	.005	.005	
2	0.01 %	.005	.005	.005	.005	.005
3	0.01 %	.01	.01	.01	.01	.01
4	0.05 %	.05	.05	.05	.05	.05
5	0.1 %	.05	.05	.05	.05	.05

TECHNICAL APPLICATIONS AND DATA

THERMISTOR TERMINOLOGY REPRINTED FROM MIL-T-23648A

3.3 Definitions

3.3.1 *Thermistor.* A thermistor is a thermally sensitive resistor whose primary function is to exhibit a change in electrical resistance with a change in body temperature.

3.3.2 *Standard reference temperature.* The standard reference temperature is the thermistor body temperature at which nominal zero-power resistance is specified (25°C).

3.3.3 *Zero-power resistance (R_T).* The zero-power resistance is the dc resistance value of a thermistor measured at a specified temperature with a power dissipation by the thermistor low enough that any further decrease in power will result in not more than 0.1 percent (or 1/10 of the specified measurement tolerance, whichever is smaller) change in resistance.

3.3.4 *Resistance ratio characteristic.* The resistance ratio characteristic identifies the ratio of the zero-power resistance of a thermistor measured at 25°C to that resistance measured at 125°C.

3.3.5 *Zero-power temperature coefficient of resistance (alpha α_T).* The Zero-power temperature coefficient of resistance is the ratio at a specified temperature (T), of the rate of change of zero-power resistance with temperature to the zero-power resistance of the thermistor.

$$\alpha_T = \frac{1}{R_T} \quad \frac{(dR_T)}{(dT)}$$

3.3.5.1 *Negative temperature coefficient (NTC).* A NTC thermistor is one in which the zero-power resistance decreases with an increase in temperature.

3.3.5.2 *Positive temperature coefficient (PTC).* A PTC thermistor is one in which the zero-power resistance increases with an increase in temperature.

3.3.6 *Maximum operating temperature.* The maximum operating temperature is the maximum body temperature at which the thermistor will operate for an extended period of time with acceptable stability of its characteristics. This temperature is the result of internal or external heating, or both, and should not exceed the maximum value specified.

3.3.7 *Maximum power rating.* The maximum power rating of a thermistor is the maximum power which a thermistor will dissipate for an extended period of time with acceptable stability of its characteristics.

3.3.8 *Dissipation constant.* The dissipation constant is the ratio, (in milliwatts per degree C) at a specified ambient temperature, of a change in power dissipation in a thermistor to the resultant body temperature change.

3.3.9 *Thermal time constant.* The thermal time constant is the time required for a thermistor to change 63.2 percent of the total difference between its initial and final body temperature when subjected to a step function change in temperature under zero-power conditions.

3.3.10 *Resistance-temperature characteristic.* The resistance-temperature characteristic is the relationship between the zero-power resistance of a thermistor and its body temperature.

3.3.11 *Temperature - wattage characteristics.* The temperature-wattage characteristic of a thermistor is the relationship at a specified ambient temperature between the thermistor temperature and the applied steady-state wattage.

3.3.12 *Current-time characteristic.* The current-time characteristic is the relationship at a specified ambient temperature between the current through a thermistor and time, upon application or interruption of voltage to it.

3.3.13 *Stability.* Stability of a thermistor is the ability of a thermistor to retain specified characteristics after being subjected to designated environmental or electrical test conditions.

THERMISTOR EQUATIONS

The following simplified equations may be used in most applications to define the Resistance-vs-Temperature characteristics of a thermistor.

$$R_T = R_{T_0} \exp\left\{\beta(1/T - 1/T_0)\right\} \quad (1)$$

R_T = zero power resistance at absolute temperature T; T = t(°C) + 273.15

R_{T_0} = zero power resistance at absolute temperature T_0; $T_0 = t_0$(°C) + 273.15

β = beta, a constant that depends on the thermistor material.

exp {x} = e, the naperian base (2.71828 . . .), raised to the power x.

Equation (1) is valid only over a narrow temperature range since the material constant, β, actually increases with increasing temperatures. The error introduced by this equation increases as the temperature span is widened. An error of ±0.3°C for a typical thermistor operated over the range of 0°C to 50°C would result from the use of this equation. A minimum of two calibration points are required or a single calibration point and a specified value for beta, β. See the paragraph on Curve Tolerances for the effect of β tolerance.

$$R_T = \exp\left\{A_0 + A_1/T + A_3/T^3\right\} \quad (2a)$$

$$1/T = a_0 + a_1 \ln R_T + a_3 [\ln R_T]^3 \quad (2b)$$

A_0, A_1 and A_3 are unique constants for Equation (2a)
a_0, a_1 and a_3 are unique constants for Equation (2b)

R_T = zero power resistance at absolute temperature T; T = t(°C) + 273.15

ln = $\log_e$

Equations (2a) and (2b) require a minimum of three calibration points in order to determine the unique set of constants. These equations may be used over moderately wide temperature spans. Errors introduced by these equations do not exceed measurement uncertainties for ranges of up to 100°C.

$$R_T = \exp\left\{A_0 + A_1/T + A_2/T^2 + A_3/T^3\right\} \quad (3a)$$

$$1/T = a_0 + a_1 \ln R_T + a_2 [\ln R_T]^2 + a_3 [\ln R_T]^3 \quad (3b)$$

Equations (3a) and (3b) require a minimum of four calibration points in order to determine the unique set of constants. These equations may be used over wider temperature spans with an improved curve fit. A maximum error of 0.0015°C was encountered for a typical thermistor operated over the range of 0°C to 100°C.

CURVE TOLERANCES:

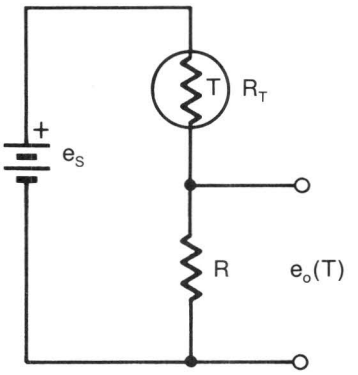
Since only nominal RESISTANCE VS. TEMPERATURE curves are normally published (see back sheet), the effect of β tolerance is frequently overlooked in specifying the proper thermistor for a given application. The chart below, taken from MIL-T-23648A, shows the effect on resistance tolerance due to standard manufacturing tolerances on β. Note that if a ± 1% resistance tolerance is specified (characteristic F) @ 25° C, this tolerance can go to ± 10% @ -55° C and 125° C.

This suggests that it is often more desirable to specify nominal resistance and resistance tolerance values at the temperatures of interest, rather than at 25° C. Many Thermometrics thermistors designed for specific customer requirements are specified in this manner.

TABLE II

Temperature (°C)	F (± %)	G (± %)	J (± %)	K (± %)	Temperature (°C)	F (± %)	G (± %)	J (± %)	K (± %)
−55	10	12	15	20	75	5	6	9	14
−15	5	6	9	14	100	7	9	12	17
0	3	4	7	12	125	10	12	15	20
25	1	2	5	10	200	15	18	25	30
50	3	4	7	12	275	20	25	35	40

LINEAR THERMISTOR VOLTAGE DIVIDER DESIGN



The output of the voltage divider is given by:

$$e_o(T) = e_s\,[R/(R+R_T)]=e_s/[1+(R_T/R)] \tag{4}$$

The RESISTANCE-TEMPERATURE CURVES on the inside back cover of this catalog provide R_T/R_{25} at any temperature, T.

$$\text{Let } r_T = R_T/R_{25} \text{ and } s = R_{25}/R. \tag{5}$$

$$\text{Then } R_T=R_{25}\,r_T \text{ and } R=R_{25}/s. \tag{6}$$

$$\text{Therefore, } e_o(T)/e_s=1/[1+s(r_T)]=F(T). \tag{7}$$

The s-curves on page L-3 can be used to obtain the best value of R for a specified thermistor and temperature range when good linearity is desired. The optimum value of s, for a specified temperature range, $T_L \leqslant T \leqslant T_H$, may also be obtained from equations (8a), (8b), and (8c) for which r_{T_L} and r_{T_H} correspond to T_L and T_H respectively and the constants A_1 and A_3 may be obtained from equation (2a). When using equations (8a), (8b), and (8c), it is possible to let $s=R_{T_o}/R$ and $r_T=R_T/R_{T_o}$ where $T_o=(T_L+T_H)/2$ (the mid-temperature of the range).

$$s=(X-Y)/(Yr_{T_L}-Xr_{T_H}) \tag{8a}$$

$$X=T_H[r_{T_L}\,(A_1 + 3A_3/T_L^2)]^{1/2} \tag{8b}$$

$$Y=T_L[r_{T_H}(A_1+ 3A_3/T_H^2)]^{1/2} \tag{8c}$$

If $T_1, R_{T_1}, T_2, R_{T_2}, T_3, R_{T_3}$ represent three thermistor calibration points such that $T_1 \leqslant T_L \leqslant T_2 \leqslant T_H \leqslant T_3$ then the constants for equation (2a) are given by

$$D=(T_1-T_3)\,(T_2-T_1)\,(T_3-T_2)\,(T_1\,T_2+T_1T_3+T_2T_3)/(T_1T_2T_3)^3 \tag{9a}$$

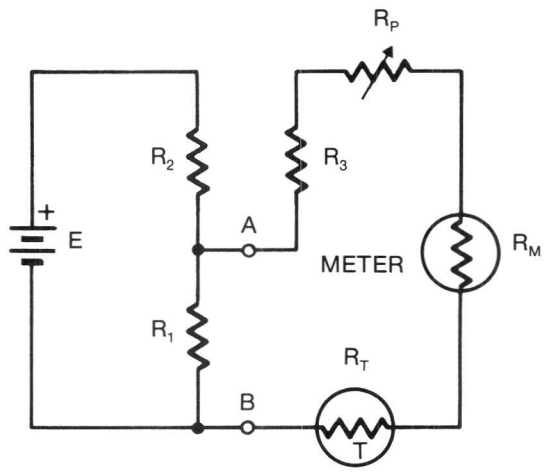
$$A_3= \left\{[(T_2-T_1)/T_1T_2]\,\ln\,(R_{T_2}/R_{T_3})-[\,(T_3-T_2)/T_2T_3]\,\ln\,(R_{T_1}/R_{T_2})\right\}/D \tag{9b}$$

$$A_1=\left\{[(T_3-T_2)(T_3^2+T_2T_3+T_2^2)/(T_2T_3)^3]\,\ln\,(R_{T_1}/R_{T_2})-[(T_2-T_1)\,(T_2^2+T_1T_2+T_1^2)/(T_1T_2)^3]\,\ln\,(R_{T_2}/R_{T_3})\right\}/D \tag{9c}$$

$$A_0= \ln R_{T_1}-(A_1/T_1)-(A_3/T_1^3) \tag{9d}$$

In the above equations, T is absolute temperature in kelvins ($T=°C+273.15$). Linear voltage dividers are frequently used in telemetry circuits.

OHMMETER THERMOMETER DESIGN



The circuit shown is a general form of Thermistor Ohmmeter Thermometer. The use of the trimpot, R_p, is optional and depends upon cost factors. The source at terminals A-B may be replaced by a Thevenin equivalent circuit comprising a source voltage $E_{THEV} = ER_1/(R_1+R_2)$ and source resistance $R_{THEV}=R_1R_2/(R_1+R_2)$. When the equivalent circuit is considered, it is apparent that the ohmmeter circuit is equivalent to the voltage divider shown on page A-3. If the output voltage is taken across the meter terminals, then $I=e_0(T)/R_M$ is linear when $e_0(T)$ is linear.

A typical application for a low cost thermistor ohmmeter circuit is an automobile water temperature gauge. Such gauges were originally designed to operate over the range of 100° F to 220° F (37.8° C to 104.4° C). Although water temperature gauges use lights, at present, a meter output will be considered to illustrate the design procedure. A suitable meter which is both rugged and inexpensive is a 0-1mA meter (R_M is approximately 50 ohms). If we let E=12 volts and E_{THEV}=6 volts, the design will be suitable for both types of batteries.

DESIGN PROCEDURE

1. From the s-curves (p. L-3) $s=R_{25}/R$ is in the range, $6 \leqslant s \leqslant 10$, where $R=R_{THEV}+R_3+R_p+R_M$.
2. Let s=8 (midway between 6 and 10).
3. Set the mid range temperature, 160° F=71.1° C, to the mid-scale meter reading of I=0.5mA. For this condition, $R+R_{71.1}$= 6v/0.5mA=12kΩ.
4. Use a THM series P100 Thermoprobe (p. C-5). Such glass probes may be operated at temperatures in excess of 300° C and will not be damaged if the engine overheats. They also are rugged and relatively inexpensive. The dissipation and time constants are 5mW/° C and 1 second respectively in still water.
5. From the R-T curves (see inside back cover) we find that $0.13 \leqslant R_{71.1}/R_{25} \leqslant 0.19$ for $10k\Omega \leqslant R_{25} \leqslant 1M\Omega$. Assume that $R_{71.1}/R_{25}$ =0.16 (midway between 0.13 and 0.19).
6. $12K\Omega=R+R_{71.1}=(R_{25}/s)+0.16\ R_{25} = 0.125\ R_{25} + 0.16R_{25} = 0.285\ R_{25}$. Hence, R_{25}=42.11kΩ.
7. From Table C, (p. C-5) we see that the closest standard value is 43kΩ at 25° C.
8. From curve 10 (p. L-2), we find that R_{30}=(.8017) (43kΩ)= 34 473Ω, R_{70}=(0.167) (43kΩ)=7181Ω, R_{110}=(.04691) (43kΩ)=2017Ω.
9. From equations (9a), (9b), (9c), and (9d), we obtain A_0= -3.934938830, A_1=4528.707767, and A_3= -15488865.20.
10. From equation (2a), we obtain $R_{37.8}$=24686, $R_{71.1}$=6909.7, and $R_{104.4}$=2373.8 which yields $R_{37.8}/R_{25}$=0.5741, $R_{71.1}/R_{25}$=0.1607, and $R_{104.4}/R_{25}$ = 0.055205.
11. Substituting in equations (8a), (8b), and (8c) yields s=43k/R=7.75, from which we obtain $R=R_{THEV}+R_3+R_p+R_M$=5548Ω and I_{mid} = 0.482mA.
12. The design parameters are E=12V, $R_1=R_2$=10kΩ, E_{THEV}=6v, R_{THEV}=5KΩ, R_3+R_p=498Ω, and R_T=P100DB433M thermoprobe.

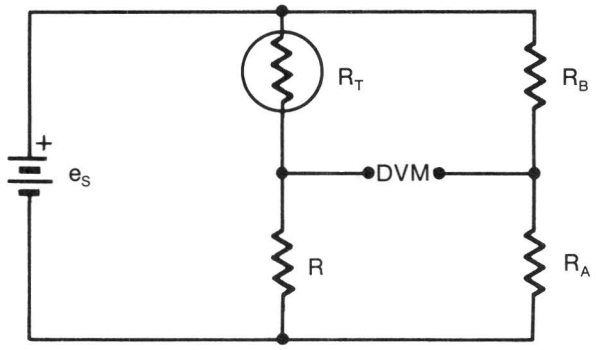


FIGURE A

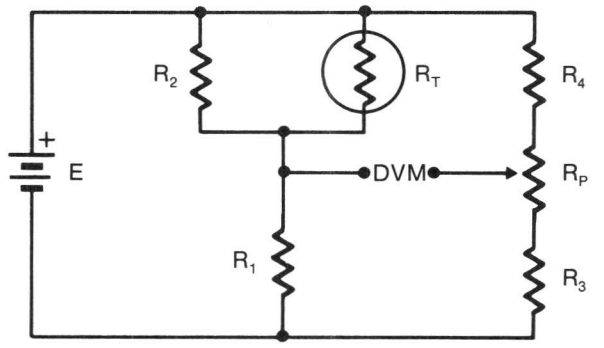


FIGURE B

Thermistors are frequently used for temperature measurements in a large variety of biomedical applications. To illustrate the use of the linear voltage divider and the design equations, a complete design of a direct reading biomedical thermistor thermometer will be provided. This design is suitable for use as a fast-response thermometer over the range of 33° C to 43° C. The design procedure is suitable for any temperature range for which satisfactory linearity can be achieved (see s-curves on p. L-3).

For the purpose of illustration, the sensor selected will be a THM series A990 fast-response, interchangeable sub-assembly (see p. J-5). For this design, the A990BUN223SX1 will be used which has a curve tolerance of 0.05° C within the design operating range. The dissipation constants are 0.36mW/° C and 1.0 mW/° C respectively, for still air and still water. The time constant for still air is 1.5 seconds while that for a plunge into water is 0.15 second. A digital panel meter or laboratory DVM will be used for the output detector. Since the input resistances for such detectors generally exceed 10MΩ, we may consider the bridge load to be an open circuit. Under these conditions, the basic bridge of Figure A is a pair of voltage dividers. The output voltage is the difference between the two divider circuits.

DESIGN PROCEDURE:

1. Let the output detector be a 0-100 mV DVM.
2. For maximum application flexibility, assume that the dissipation constant is 0.36 mW/° C (its lowest anticipated value).
3. We begin by designing the voltage divider e_s, R_T, R.
4. From the R-T tables for the series A990 (p. J-6), we obtain R_{25}=11kΩ, R_{35}=7531.1Ω, and R_{50}=4435.6Ω (UN223 table).
5. From equations (9a), (9b), (9c), and (9d) we obtain A_0=-3.328203678, A_1=3917.051236, and A_3=-13357800.88.
6. From equation (2a) we obtain $R_{T_L}=R_{33}$=8109.829488Ω, $R_{T_O}=R_{38}$=6750.109743Ω, $R_{T_H}=R_{43}$=5647.251706Ω, $r_{T_L}=R_{33}/R_{38}$=1.201436687, and $r_{T_H}=R_{43}/R_{38}$=0.836616281.
7. From equations (8a), (8b), and (8c) we obtain X=20470.34967, Y=16604.63244, $s=R_{T_O}/R$=6750.109743/R=1.369080369, and R=4930.396999.
8. Allow a self-heating error, Δt=0.01° C. Then P_{MAX}=0.36 (10-³) W/° C X 0.01° C, ($e_s^2/4R$)=0.36 (10-⁵)=$e_s^2/4$ (4930.40) and $e_s \leqslant 0.26645$ volt.
9. Using equation (2a) for R_T, $r_T=R_T/R_{T_O}=R_T/R_{38}$, and equation (7) for F(T), perform a linear regression for $F(T)=e_0(T)/e_s=a_o+a_1t$ where $a_1=[(n\Sigma t_i F(t_i)-\Sigma t_i \Sigma F(t_i)]/[n\Sigma t_i^2-(\Sigma t_i)^2]$, $a_0=[\Sigma F(t_i)-a_1\Sigma t_i]/n$, and n is the number of temperature points, t_i, used for the range specified. Using 1° C increments between 33° C and 43° C, we obtain a_1=8.809268178 (10-³) and a_0=8.735164300 (10-²).
10. The output voltage is given by $e_0(T)=e_sF(T)=a_0e_s+a_1e_st$. Set the slope of the output a_1e_s, to 1mV/°C. Hence, a_1e_s=8.809268178 (10-³) e_s=10-³V/° C, e_s=0.1135168075 volt, and e_0 (t)=9.915879643 (10-³)+10-³t volts or $e_0(T)$= 9.915879643+t mV. The actual maximum self-heating error is 0.001° C.
11. The output of the divider e_s, R_A, R_B provides a bias, $e_b=e_sR_A/(R_A+R_B)$ and the bridge output is $e_{0_B}=e_0(T)-e_b$. For the bridge output in mV to be direct reading in ° C, we require that e_{0_B}=10-³t volt=9.915879643 (10-³)+10-³ t-e_b. Hence, $e_b=e_sR_A/(R_A+R_B)$=0.1135168075R_A/ (R_A+R_B)=9.915879643 (10-³).
12. Let R_A=1000Ω. Then $R_B=R_A[(e_s/e_b)-1]$=10447.9816Ω.
13. Convert the circuit of Figure A to the practical circuit of Figure B using E=any desired voltage source, R_1= RE/e_s, $R_2=RR_1/(R_1-R)$, R_3= any desired value,and $R_4=R_3\{[E/(e_b+E-e_s)]-1\}$. In computing R_4 it is assumed that R_p=0. The values of $R_3$and R_4 should be selected such that $E/(R_3+R_4)$ is consistent with the allowable current drain for the supply available. The use of R_p permits standard values for R_3 and R_4. For E=5 volts, R_1= 217166Ω and R_2= 5044.93Ω.
14. In the absence of any specific constraint, let $E/(R_3+R_4)$=1mA. Then 10-³=5/(R_3+R_4), R_3+R_4=5000Ω, and $R_4=R_3\{[5/(9.915879643X10^{-3}+5-0.1135168075)]-1\}$=0.021158595$R_3$. This results in R_3=4896.399Ω and R_4=103.601Ω. Since these are non-standard values, let R_3=4700Ω which requires that R_4=99.445Ω for proper bias. Since R_4 is non-standard, let R_4=100Ω and R_p=10Ω.

Complete design parameters for Figure B are shown in the table below for all of the thermistors available for use with the series A990 Interchangeable Sub-Assemblies for the range of 33° C to 43° C.

TABLE III

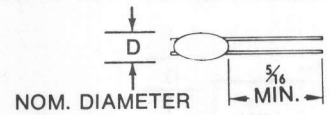
DESIGN PARAMETER	RESISTANCE CODES					
	UN103	UT103	UN223	UT223	UN443	UT443
E (VOLTS)	5	5	5	5	5	5
R_1 ohms	97225.3	389028.0	217166.0	868216.0	443291.0	1773289.0
R_2 ohms	228.91	9158.10	5044.93	20168.00	9930.03	39722.42
R_3 ohms	4700	4700	4700	4700	4700	4700
R_4 ohms	100	100	100	100	100	100
R_p ohms	10	10	10	10	10	10
MAX ERROR (° C)	0.005	0.005	0.004	0.005	0.005	0.005

THERMOBEADS SERIES BB05, BB07 & BB11

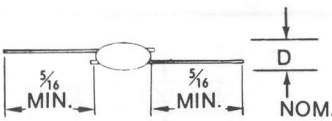
STYLE: The series BB05, BB07 and BB11 THERMOBEADS consist of miniature bead thermistors which are sintered onto fine platinum alloy wires. These thermistor beads are the bare counterparts of the glass coated bead thermistor series BR11, BR16 and BR23 series, respectively.

APPLICATIONS: The bare bead thermistors are not as stable as their glass coated counterparts. They offer the advantages of faster response and lower cost than the glass coated THERMOBEADS. Their use in high temperatures or severe environments is not recommended. They may be used in microwave power measurement applications or for general temperature measurement and control applications when the environmental exposures are limited or controlled by such means as encapsulation into a housing.

MAXIMUM TEMPERATURE: The series BB05, BB07 and BB11 THERMOBEADS exhibit best stability characteristics when the temperature is 105°C or less. Degraded stability will occur if the devices are operated or stored at temperatures up to 150°C. The use of bare bead thermistors is not recommended above 150°C.



ADJACENT LEADS
"J"



OPPOSITE LEADS
"P"

LEADS ARE PLATINUM ALLOY
ALL DIMENSIONS ARE IN INCHES

	"D" NOM. DIA.	LEAD DIA.
SERIES BB05	.005"	.0007"
SERIES BB07	.007"	.0011"
SERIES BB11	.011"	.002"

RESISTANCE VS. TEMPERATURE CHARACTERISTIC - The bare bead thermistor standard resistance values, the nominal resistance ratio between 25°C and 125°C, the material system code letter and curve number may be obtained by referring to the appropriate glass coated thermistor bead data sheets:

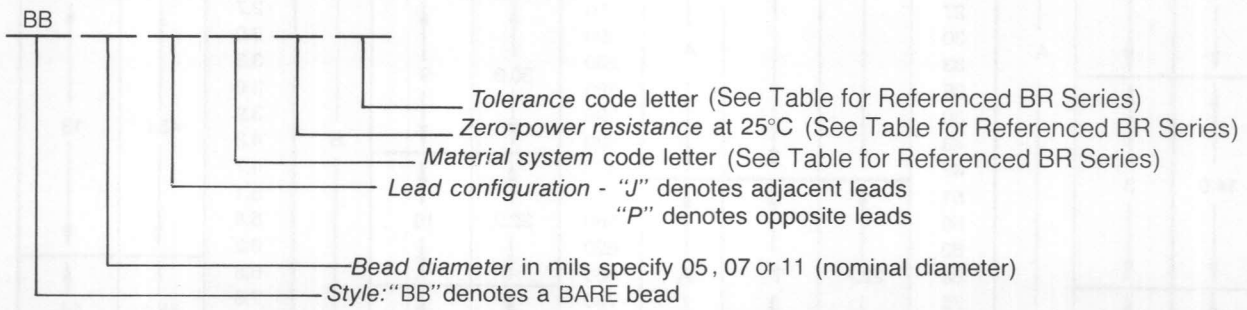
SERIES BB05 - See TABLE A (SERIES BR11) PAGE B-8
SERIES BB07 - See TABLE B (SERIES BR16) PAGE B-10
SERIES BB11 - See TABLE B (SERIES BR23) PAGE B-12

THERMAL AND ELECTRICAL PROPERTIES (Definitions and test methods per MIL-T-23648)

		Series BB05	Series BB07	Series BB11
Thermal Time Constant	in still air	0.11 sec	0.2 sec	0.65 sec
	water plunge	4.5 mSec	6 mSec	11 mSec
Dissipation Constant	in still air	.05mW/°C	.07mW/°C	.095mW/°C
	in still water	.25mW/°C	.35mW/°C	.47mW/°C
Resistance Range		1K to 10M	300 to 10M	300 to 10M
Maximum Power Rating		.004 watts	.006 watts	.008 watts

ORDERING INFORMATION

The Code Number to be ordered may be specified as follows:



For example. a 0.005 inch nominal diameter BARE THERMOBEAD with opposite leads having a zero-power resistance of 2000Ω and a tolerance of ±25% would be specified as BB05PA202N

OPTIONS:

The standard units may be modified to suit the users particular needs by specifying any of the following options:

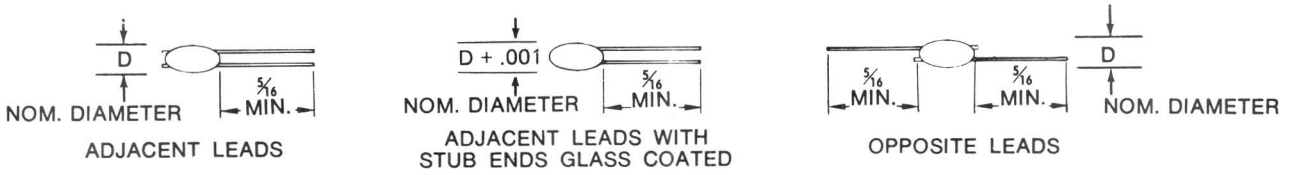
- Non-standard resistance values.
- Reference temperature(s) other than 25°C.
- Non-standard tolerances (at one or more temperatures).
- Solderable or weldable and solderable leads.
- Special mountings and enclosures.
- Calibration - specify temperature(s).

THERMOBEADS
SERIES B05 and B07

All THERMOBEADS are designed to meet or exceed the performance requirements of MIL-T-23648.

STYLE: The series B05 and B07 THERMOBEADS consist of miniature bead thermistors which are hermetically sealed by means of specially selected glass coatings. These units exhibit excellent stability and are unaffected by severe environmental exposures, including high density nuclear radiation.

The series B05 and B07 THERMOBEADS are characterized by very fast response times and relatively high power sensitivity. As such, they are particularly well suited for temperature measurement and control applications requiring very small, low heat capacity sensors, as well as self-heated applications such as gas chromatography, liquid level measurement and control, thermal conductivity analysis and gas flow measurement.



LEADS ARE 0.0007 PLATINUM ALLOY
ALL DIMENSIONS ARE IN INCHES

NOM. DIAMETER	D
SERIES B05	0.005
SERIES B07	0.007

RESISTANCE VS. TEMPERATURE CHARACTERISTIC - The nominal standard values for the Zero-Power Resistance at 25°C, R_{25}, are shown in Table A. Also shown are the nominal Resistance Ratio between 25°C and 125°C, R_{25}/R_{125}, and the material system code letter (MS).

TABLE A - STANDARD RESISTANCE VALUES*

R_{25} KΩ	$\frac{R_{25}}{R_{125}}$	R-T Curve	MS	R_{25} KΩ	$\frac{R_{25}}{R_{125}}$	R-T Curve	MS	R_{25} KΩ	$\frac{R_{25}}{R_{125}}$	R-T Curve	MS	R_{25} MΩ	$\frac{R_{25}}{R_{125}}$	R-T Curve	MS
1.0	11.8	1	A	10	16.9	4	A	100	22.7	7	A	1.0	35.7	11	B
1.1				11				110				1.1			
1.2				12				120				1.2			
1.3				13				130				1.3			
1.5	12.5	2		15	19.8	5		150	29.4	8		1.5	38.1	12	
1.6				16				160				1.6			
1.8				18				180				1.8			
2.0				20				200				2.0			
2.2				22				220				2.2			
2.4				24				240				2.4			
2.7	14.0	3		27	22.7	7	A	270	30.8	9	B	2.7	45.0	13	
3.0				30				300				3.0			
3.3				33				330				3.3			
3.6				36				360				3.6			
3.9				39				390				3.9			
4.3				43				430				4.3			
4.7				47				470				4.7			
5.1				51				510	32.3	10		5.1			
5.6				56				560				5.6			
6.2				62				620				6.2			
6.8				68				680				6.8			
7.5	16.9	4		75				750	35.7	11		7.5	48.1	14	
8.2				82				820				8.2			
9.1				91				910				9.1			

*The resistance values shown are from the standard 24-value series decade shown in MIL-T-23648. Other values, as well as values specified at other reference temperatures, are available on request.

See Curves Pages L-1 and L-2

Thermobeads — Series BO5 and BO7

TABLE 1 - STANDARD TOLERANCES

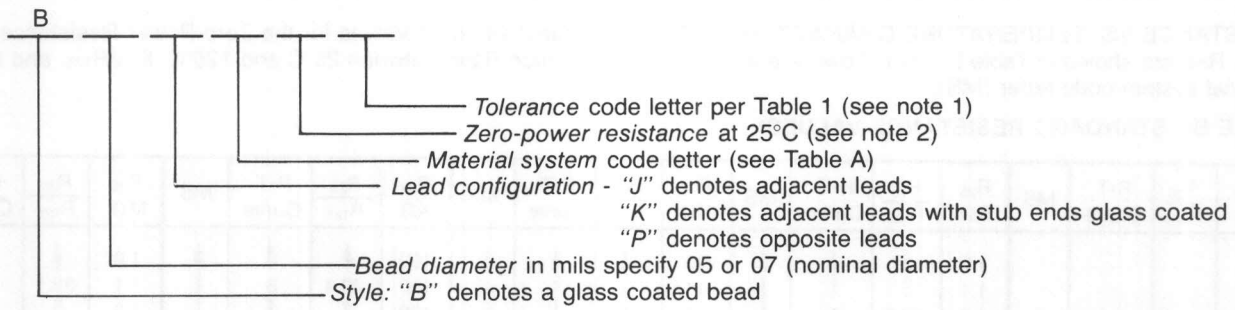
Tolerance Code Letter	F	G	J	K	L	M	N	P	Q	R	S
±% Tolerance @25°C	1	2	5	10	15	20	25	30	40	50	Non-Standard (Specify value)

THERMAL AND ELECTRICAL PROPERTIES
(Definitions and test methods per MIL-T-23648)

		Series B05	Series B07	
Thermal Time Constant	in still air	0.12 sec.	0.23 sec.	
	water plunge	5 mSec.	7 mSec.	
Dissipation Constant	in still air	.045mW/°C	.06mW/°C	
	in still water	.23mW/°C	.30mW/°C	
Resistance Range		1K to 10M ohms	1K to 10M ohms	See Table A for standard values
Maximum Power Rating		.006 watts	.008 watts	

Maximum Temperature - All THERMOBEADS are aged at 300°C for extended periods of time. As such, they exhibit excellent stability for all temperatures at or below 300°C. Intermittent operation at temperatures up to 600°C is permissible. When additional pre-conditioning is specified, compliance with the performance requirements of MIL-T-23648 can be guaranteed.

ORDERING INFORMATION
The Code Number to be ordered may be specified as follows:



Notes: 1) Special tolerances are available on request. To specify a non-standard tolerance, use the letter "S" followed by the desired tolerance (i.e., S3=±3%).

2) The zero-power resistance at 25°C, expressed in ohms, is identified by a three digit number. The first two digits represent significant figures, and the last digit specifies the number of zeros to follow.

For example. a 0.005 inch nominal diameter glass coated THERMOBEAD with opposite leads having a zero-power resistance of 2000Ω and a tolerance of ±25% would be specified as B05PA202N.

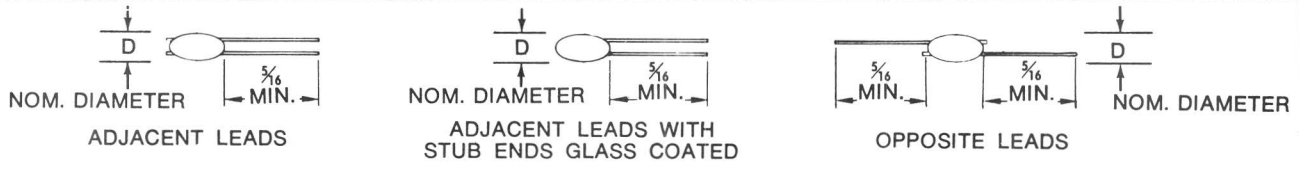
OPTIONS:
The standard units may be modified to suit the users particular needs by specifying any of the following options:

- Non-standard resistance values.
- Reference temperature(s) other than 25°C.
- Non-standard tolerances (at one or more temperatures).
- Longer continuous leads.
- Welded or soldered extension leads - specify lead material, diameter, length, and insulation, if any.
- Solderable or weldable and solderable leads.
- Special mountings and enclosures.
- Calibration - specify temperature(s).
- Interchangeable pairs, sets; curve matching - specify temperature(s) and tolerance(s).
- Special aging for high reliability applications.

THERMOBEADS
SERIES B10 and B14

All THERMOBEADS are designed to meet or exceed the performance requirements of MIL-T-23648.

STYLE: The series B10 and B14 THERMOBEADS consist of miniature bead thermistors which are hermetically sealed by means of specially selected glass coatings. These units exhibit excellent stability and are unaffected by severe environmental exposures. Special designs are available (series BH10 and BH14) for continuous exposure to highly reactive gases, such as hydrogen. The series B10 and B14 THERMOBEADS are characterized by very fast response times and relatively high power sensitivity. As such, they are particularly well suited for temperature measurement and control applications requiring very small, low heat capacity sensors, as well as self-heated applications such as gas chromatography, liquid level measurement and control, thermal conductivity analysis and gas flow measurement. For high frequency applications, such as microwave power measurement, units are available with controlled capacitance (Series BC10 and BC14).



LEADS ARE 0.001 PLATINUM ALLOY

ALL DIMENSIONS ARE IN INCHES

NOM. DIAMETER	D
SERIES B10	0.010
SERIES B14	0.014

RESISTANCE VS. TEMPERATURE CHARACTERISTIC - The nominal standard values for the Zero-Power Resistance at 25°C, R_{25}, are shown in Table B. Also shown are the nominal Resistance Ratio between 25°C and 125°C, R_{25}/R_{125}, and the material system code letter (MS).

TABLE B - STANDARD RESISTANCE VALUES*

R_{25} Ω	$\frac{R_{25}}{R_{125}}$	R-T Curve	MS	R_{25} KΩ	$\frac{R_{25}}{R_{125}}$	R-T Curve	MS	R_{25} KΩ	$\frac{R_{25}}{R_{125}}$	R-T Curve	MS	R_{25} KΩ	$\frac{R_{25}}{R_{125}}$	R-T Curve	MS	R_{25} MΩ	$\frac{R_{25}}{R_{125}}$	R-T Curve	MS
				1.0				10				100				1.0			
				1.1				11				110	29.4	8		1.1	38.1	12	
				1.2	12.5	2		12				120				1.2			
				1.3				13				130				1.3			
				1.5				15	19.8	5	A	150	30.8	9		1.5			
				1.6				16				160				1.6			
				1.8				18				180				1.8			
				2.0				20				200				2.0	45.0	13	
				2.2				22				220				2.2			
				2.4	14.0	3		24				240				2.4			
				2.7				27				270	32.3	10		2.7			
300				3.0				30				300				3.0			
330				3.3				33				330				3.3			
360				3.6				36				360				3.6			
390				3.9				39				390				3.9			
430	11.8	1		4.3				43	22.7	7	A	430				4.3	48.1	14	
470				4.7	16.9	4		47				470				4.7			
510			A	5.1				51				510	35.7	11		5.1			
560				5.6				56				560				5.6			
620				6.2				62				620				6.2			
680				6.8				68				680				6.8			
750	12.5	2		7.5	19.8	5		75				750				7.5	56.5	15	
820				8.2				82	29.4	8	B	820	38.1	12		8.2			
910				9.1				91				910				9.1			

*The resistance values shown are from the standard 24-value series decade shown in MIL-T-23648. Other values, as well as values specified at other reference temperatures, are available on request.

See Curves Pages L-1 and L-2

THERMOMETRICS 808 U.S. HIGHWAY 1 EDISON, NEW JERSEY 08817 TEL. 201-287-2870

Thermobeads — Series B10 and B14

TABLE 1 - STANDARD TOLERANCES

Tolerance Code Letter	F	G	J	K	L	M	N	P	Q	R	S
±% Tolerance @ 25°C	1	2	5	10	15	20	25	30	40	50	Non-Standard (Specify value)

THERMAL AND ELECTRICAL PROPERTIES

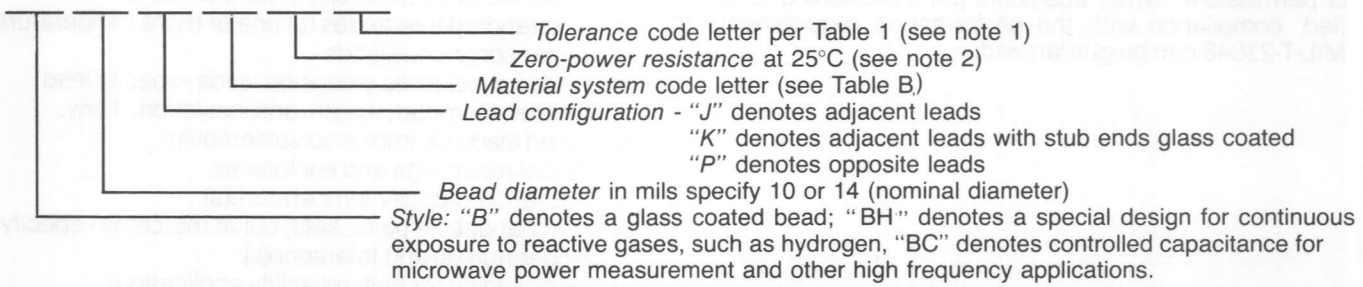
(Definitions and test methods per MIL-T-23648)

		Series B10	Series B14	
Thermal Time Constant	in still air	0.5 sec.	1.0 sec.	
	water plunge	10 mSec.	15 mSec.	
Dissipation Constant	in still air	.09mW/°C	.10mW/°C	
	in still water	.45mW/°C	.50mW/°C	
Resistance Range		300 to 10M ohms	300 to 10M ohms	See Table B for standard values
Maximum Power Rating		.010 watts	.014 watts	

All THERMOBEADS are aged at 300°C for extended periods of time. As such, they exhibit excellent stability for all temperatures at or below 300°C. Intermittent operation at temperatures up to 600°C is permissible. When additional pre-conditioning is specified, compliance with the performance requirements of MIL-T-23648 can be guaranteed.

ORDERING INFORMATION

The Code Number to be ordered may be specified as follows:



Notes: 1) Special tolerances are available on request. To specify a non-standard tolerance, use the letter "S" followed by the desired tolerance (i.e., S3 = ±3%).

2) The zero-power resistance at 25°C, expressed in ohms, is identified by a three digit number. The first two digits represent significant figures, and the last digit specifies the number of zeros to follow.

For example, a 0.014 inch nominal diameter glass coated THERMOBEAD with opposite leads having a zero-power resistance of 2000Ω and a tolerance of ±25% would be specified as B14PA202N.

OPTIONS:

The standard units may be modified to suit the users particular needs by specifying any of the following options:

- Non-standard resistance values.
- Reference temperature(s) other than 25°C.
- Non-standard tolerances (at one or more temperatures).
- Longer continuous leads.
- Welded or soldered extension leads - specify lead material, diameter, length, and insulation, if any.
- Solderable or weldable and solderable leads.
- Special mountings and enclosures.
- Calibration - specify temperature(s).
- Interchangeable pairs, sets; curve matching - specify temperature(s) and tolerance(s).
- Special aging for high reliability applications.

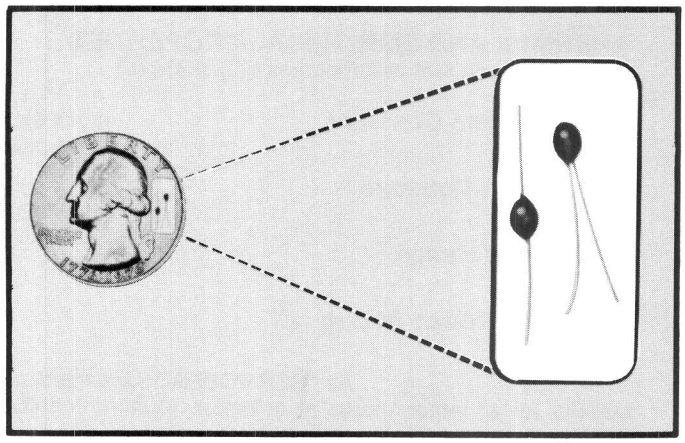
SERIES B35 and B43

All THERMOBEADS are designed to meet or exceed the performance requirements of MIL-T-23648.

STYLE: The series B35 and B43 THERMOBEADS consist of a bead thermistor hermetically sealed with a shock resistant glass coating. These units exhibit excellent stability and are unaffected by severe environmental exposures. The units are elliptical in shape with nominal diameters of 0.035 and 0.043 inches, respectively.

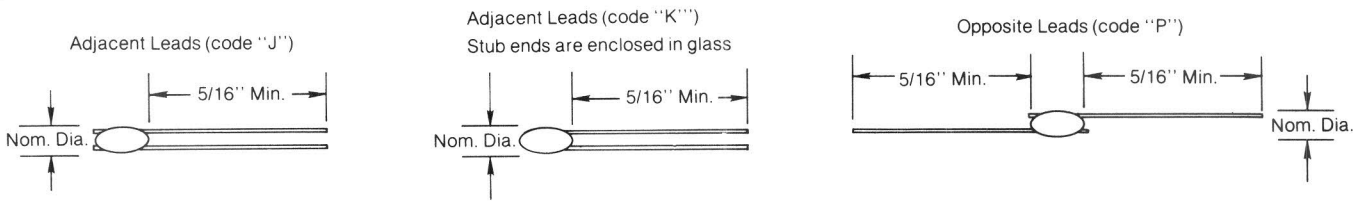
APPLICATIONS: The series B35 and B43 THERMOBEADS are recommended for applications where smaller dimensions and fast response times are required. The series B35 and B43 THERMOBEADS are ideally suited for most low cost applications involving temperature measurement, control, compensation, liquid level or flow sensing.

MAXIMUM TEMPERATURE: All THERMOBEADS are aged at 300 °C for extended periods of time. As such, they exhibit excellent stability for all temperatures at or below 300 °C. Intermittent operation at temperatures up to 600 °C is permissible. When additional pre-conditioning is specified, compliance with the performance requirements of MIL-T-23648 can be guaranteed.



OPTIONS - The standard units may be modified to suit the users particular needs by specifying any of the following options:

- Non-standard resistance values.
- Reference temperature(s) other than 25 °C.
- Non-standard tolerances (at one or more temperatures).
- Longer continuous leads.
- Welded or soldered extension leads - specify lead material, diameter, length, and insulation, if any.
- Tinned leads for improved solderability.
- Special mountings and enclosures.
- Calibration - specify temperature(s).
- Interchangeable pairs, sets; curve matching - specify temperature(s) and tolerance(s).
- Special aging for high reliability applications.



Series	Nom. Dia.
B35	.035"
B43	.043"

All dimensions are in inches

Leads are platinum alloy 0.004" dia.

THERMAL AND ELECTRICAL PROPERTIES

(Definitions and test methods per MIL-T-23648)

		SERIES B35	SERIES B43
DISSIPATION CONSTANT	(Still air @ 25 °C)	0.30 mW/ °C	0.35 mW/ °C
	(Still water @ 25 °C)	1.50 mW/ °C	2.00 mW/ °C
THERMAL TIME CONSTANT	(Still air)	4.5 seconds	5.5 seconds
	(Plunge into water)	100 msec	140 msec
RESISTANCE RANGE	30 ohms to 20 megohm - see Table C for standard values.		
MAXIMUM POWER RATING	.035 watts max. - 100% of max. power up to 150 °C then derate linearly to 0% at 300 °C.		

Thermobeads - Series B35 and B43

RESISTANCE VS. TEMPERATURE CHARACTERISTIC — The nominal standard values for the Zero-Power Resistance at 25 °C, R_{25}, are shown in Table C. Also shown are the nominal Resistance Ratio between 25 °C and 125 °C, R_{25}/R_{125}, and the material system code letter (MS).

TABLE C - STANDARD RESISTANCE VALUES*

R_{25} Ω	$\frac{R_{25}}{R_{125}}$	R-T Curve	MS	R_{25} Ω	$\frac{R_{25}}{R_{125}}$	R-T Curve	MS	R_{25} KΩ	$\frac{R_{25}}{R_{125}}$	R-T Curve	MS	R_{25} KΩ	$\frac{R_{25}}{R_{125}}$	R-T Curve	MS	R_{25} KΩ	$\frac{R_{25}}{R_{125}}$	R-T Curve	MS	R_{25} MΩ	$\frac{R_{25}}{R_{125}}$	R-T Curve	MS
30	5.0		E	300	12.5	2		3.0	19.8	5		30	30.8	9		300	38.1	12		3.0			
33				330				3.3				33				330				3.3			
36				360				3.6				36				360				3.6			
39				390				3.9				39				390				3.9			
43				430				4.3	22.1	6	A	43				430				4.3			
47				470	14.0	3		4.7				47	32.3	10		470	45.0	13		4.7	75.6	16	
51				510				5.1				51				510				5.1			
56				560				5.6				56				560				5.6			
62				620				6.2				62				620				6.2			
68				680				6.8	22.7	7	A	68				680				6.8			
75				750				7.5				75				750				7.5			D
82	11.8	1		820				8.2				82				820				8.2			
91				910				9.1				91			B	910			B	9.1			
100				1000	16.9	4	A	10				100	35.7	11		1000	48.1	14		10.0			
110				1100				11				110				1100				11.0			
120				1200				12				120				1200				12.0			
130				1300				13				130				1300				13.0	81.0		
150				1500				15	29.4	8	B	150				1500				15.0			
160				1600				16				160				1600				16.0			
180				1800				18				180				1800	56.5	15		18.0			
200	12.5	2		2000	19.8	5		20				200	38.1	12		2000				20.0			
220				2200				22				220				2200							
240				2400				24				240				2400							
270				2700				27	30.8	9		270				2700							

*The resistance values shown are from the standard 24-value series decade shown in MIL-T-23648. Other values, as well as values specified at other reference temperatures, are available on request.

See Curves Pages L-1 and L-2

TABLE 1 - STANDARD TOLERANCES

Tolerance Code Letter	F	G	J	K	L	M	N	P	Q	R	S
± % Tolerance @ 25° C	1	2	5	10	15	20	25	30	40	50	Non-Standard (Specify value)

ORDERING INFORMATION

The Code Number to be ordered may be specified as follows:

B

- Tolerance code letter per Table 1 (see note 1)
- Zero-power resistance at 25 °C (see note 2)
- Material system code letter (see Table C)
- Lead configuration - "J" denotes adjacent leads
  "K" denotes adjacent leads with stub ends glass coated
  "P" denotes opposite leads
- Bead diameter in mils (specify 35 or 43)
- Style: "B" denotes a glass coated bead

Notes: 1) Special tolerances are available on request. To specify a non-standard tolerance, use the letter "S" followed by the desired tolerance (i.e., S3 = ±3%).
2) The zero-power resistance at 25 °C, expressed in ohms, is identified by a three digit number, the first two digits represent significant figures, and the last digit specifies the number of zeros to follow.
For example, a 0.043 inch nominal diameter glass coated THERMOBEAD with opposite leads, having a zero power resistance at 25 °C of 2000 Ω , and a tolerance of ±20%, would be specified as B43PA202M.

THERMOBEADS

SERIES BR11

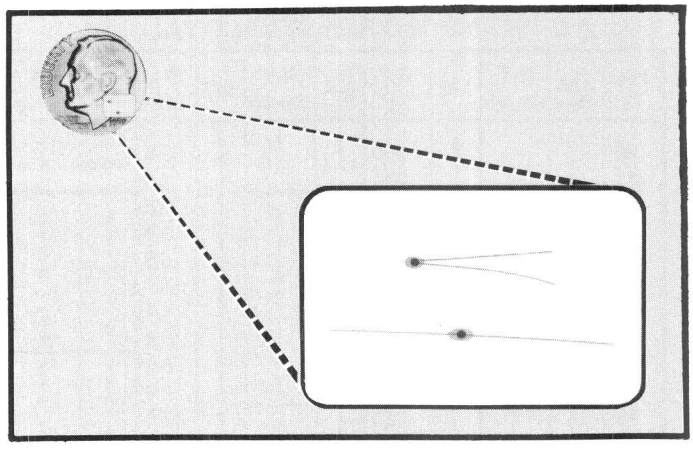
Ruggedized

All ruggedized THERMOBEADS are designed to meet or exceed the performance requirements of MIL-T-23648. Their use is recommended for military applications and commercial applications for which high reliability is a requirement.

STYLE: The series BR11 THERMOBEADS are a ruggedized version of the glass coated bead thermistors (series B05 and B07). These ruggedized THERMOBEADS exhibit greater stability than their conventional glass coated counterparts in that a much better strain relief is provided for the lead wire-glass interface as well as a superior hermetic seal. The series BR11 THERMOBEADS are the smallest, fastest response, ruggedized bead thermistors available.

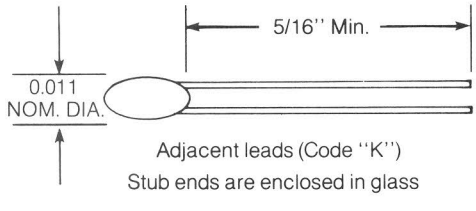
APPLICATIONS: The series BR11 ruggedized THERMOBEADS are ideally suited for applications in which the thermistor lead wires may be inadvertantly tugged. With conventional glass coated bead thermistors, the glass seal may be ruptured and, in some cases, the strain may be transmitted to the lead wire-ceramic interface during assembly operations. The ruggedized THERMOBEADS were developed to eliminate such problems.

MAXIMUM TEMPERATURE: All ruggedized THERMOBEADS are aged at 300 °C for extended periods of time. As such, they exhibit excellent stability for all temperatures at or below 300 °C. Intermittent operation at temperatures up to 600 °C is permissible. When additional pre-conditioning is specified, compliance with the performance requirements of MIL-T-23648 can be guaranteed.

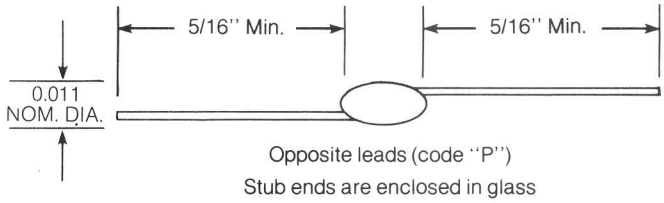


OPTIONS - The standard units may be modified to suit the users particular needs by specifying any of the following options:

- Non-standard resistance values.
- Reference temperatures other than 25 °C.
- Non-standard tolerances (at one or more temperatures).
- Longer continuous leads.
- Welded or soldered extension leads - specify lead material, diameter, length, and insulation, if any.
- Tinned leads for improved solderability.
- Special mountings and enclosures.
- Calibration - specify temperature(s).
- Special aging for high reliability applications.
- Interchangeable pairs, sets; curve matching - specify temperature(s) and tolerance(s).



Adjacent leads (Code "K")
Stub ends are enclosed in glass



Opposite leads (code "P")
Stub ends are enclosed in glass

Leads are platinum alloy 0.0007" dia.

THERMAL AND ELECTRICAL PROPERTIES

(Definitions and test methods per MIL-T-23648).

		SERIES BR11
DISSIPATION CONSTANT	(Still air @ 25 °C) (Still water @ 25 °C)	.065 mW/ °C .33 mW/ °C
THERMAL TIME CONSTANT	(Still air) (Plunge into water)	0.8 sec 12 msec
RESISTANCE RANGE	1.0K ohm to 10 megohm - see Table A for standard values.	
MAXIMUM POWER RATING	.007 watts max. - 100% of max. power up to 125 °C then derate linearly to 0% at 300 °C.	

Thermobeads - BR11

RESISTANCE VS. TEMPERATURE CHARACTERISTIC - The nominal standard values for the Zero-Power Resistance at 25 °C, R_{25}, are shown in Table A. Also shown are the nominal Resistance Ratio between 25 °C and 125 °C, R_{25}/R_{125}, and the material system code letter (MS).

TABLE A - STANDARD RESISTANCE VALUES*

R_{25} KΩ	$\frac{R_{25}}{R_{125}}$	R-T Curve	MS	R_{25} KΩ	$\frac{R_{25}}{R_{125}}$	R-T Curve	MS	R_{25} KΩ	$\frac{R_{25}}{R_{125}}$	R-T Curve	MS	R_{25} MΩ	$\frac{R_{25}}{R_{125}}$	R-T Curve	MS
1.0	11.8	1	A	10	16.9	4	A	100	22.7	7	A	1.0	35.7	11	B
1.1				11				110				1.1			
1.2				12				120				1.2			
1.3				13				130				1.3			
1.5	12.5	2		15	19.8	5		150	29.4	8		1.5	38.1	12	
1.6				16				160				1.6			
1.8				18				180				1.8			
2.0				20				200				2.0			
2.2				22				220				2.2			
2.4				24				240				2.4			
2.7				27				270				2.7	45.0	13	
3.0				30				300				3.0			
3.3				33				330	30.8	9		3.3			
3.6				36				360				3.6			
3.9				39				390				3.9			
4.3				43				430			B	4.3			
4.7	14.0	3		47				470				4.7			
5.1				51				510				5.1			
5.6				56				560	32.3	10		5.6			
6.2				62				620				6.2			
6.8				68	22.7	7	A	680				6.8			
7.5				75				750				7.5	48.1	14	
8.2	16.9	4		82				820	35.7	11		8.2			
9.1				91				910				9.1			

*The resistance values shown are from the standard 24-value series decade shown in MIL-T-23648. Other values, as well as values specified at other reference temperatures, are available on request.

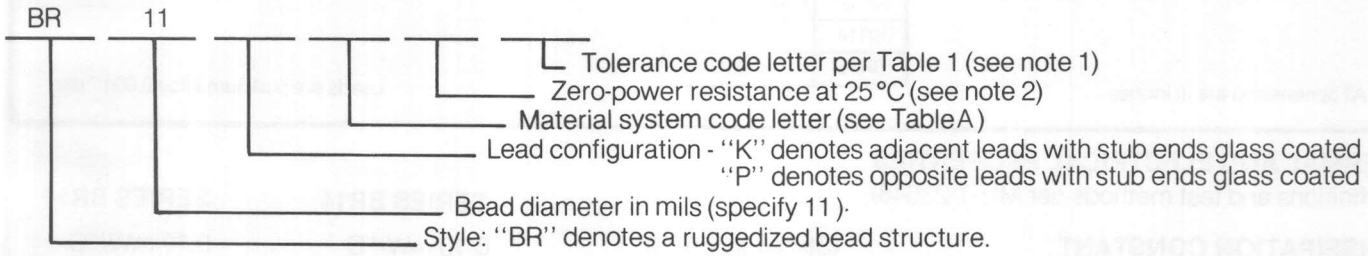
See Curves Pages L-1 and L-2

TABLE 1 - STANDARD TOLERANCES

Tolerance Code Letter	F	G	J	K	L	M	N	P	Q	R	S
± % Tolerance @ 25 °C	1	2	5	10	15	20	25	30	40	50	Non-Standard (Specify value)

ORDERING INFORMATION

The Code Number to be ordered may be specified as follows:



Notes: 1) Special tolerances are available on request. To specify a non-standard tolerance, use the letter "S" followed by the desired tolerance (i.e., S3 = ±3%).
2) The zero-power resistance 25 °C, expressed in ohms, is identified by a three digit number. The first two digits represent significant figures, and the last digit specifies the number of zeros to follow.

For example, a 0.011 inch nominal diameter ruggedized THERMOBEAD with adjacent leads, having a zero-power resistance of 2000 Ω, and a tolerance of ±25%, would be specified as BR11KA202N.

THERMOBEADS

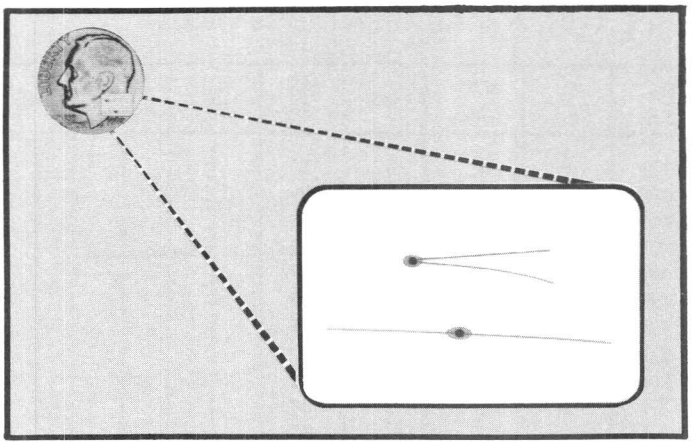
SERIES BR14 and BR16
Ruggedized

All ruggedized THERMOBEADS are designed to meet or exceed the performance requirements of MIL-T-23648. Their use is recommended for military applications and commercial applications for which high reliability is a requirement.

STYLE: The series BR14 and BR16 ruggedized THERMOBEADS are actually a cross between the glass coated bead thermistor (series B14 THERMOBEADS) and the miniature glass probe thermistor (series P20 THERMOPROBES). As such they combine the ruggedness and high reliability of the probe design with the smaller size offered by the bead design. These ruggedized THERMOBEADS exhibit greater stability than their conventional glass coated counterparts in that a much better strain relief is provided for the lead wire-glass interface as well as a superior hermetic seal.

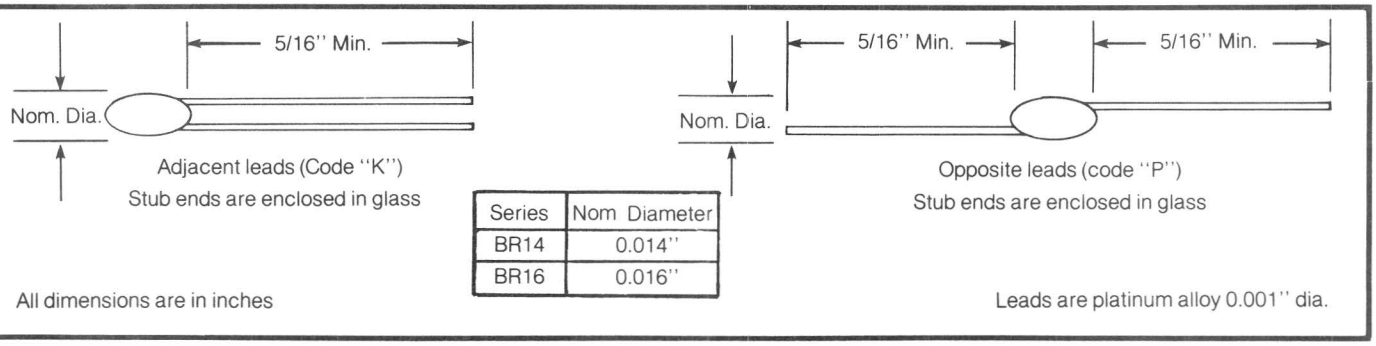
APPLICATIONS: The series BR14 and BR16 ruggedized THERMOBEADS are ideally suited for applications in which the thermistor lead wires may be inadvertantly tugged. With conventional glass coated bead thermistors, the glass seal may be ruptured and, in some cases, the strain may be transmitted to the lead wire-ceramic interface during assembly operations. The ruggedized THERMOBEADS were developed to eliminate such problems.

MAXIMUM TEMPERATURE: All ruggedized THERMOBEADS are aged at 300 °C for extended periods of time. As such, they exhibit excellent stability for all temperatures at or below 300 °C. Intermittent operation at temperatures up to 600 °C is permissible. When additional pre-conditioning is specified, compliance with the performance requirements of MIL-T-23648 can be guaranteed.



OPTIONS The standard units may be modified to suit the users particular needs by specifying any of the following options:

- Non-standard resistance values.
- Reference temperatures other than 25 °C.
- Non-standard tolerances (at one or more temperatures).
- Longer continuous leads.
- Welded or soldered extension leads - specify lead material, diameter, length, and insulation, if any.
- Tinned leads for improved solderability.
- Special mountings and enclosures.
- Calibration - specify temperature(s).
- Special aging for high reliability applications.
- Interchangeable pairs, sets; curve matching - specify temperature(s) and tolerance(s).



Series	Nom Diameter
BR14	0.014"
BR16	0.016"

THERMAL AND ELECTRICAL PROPERTIES

(Definitions and test methods per MIL-T-23648).

		SERIES BR14	SERIES BR16
DISSIPATION CONSTANT	(Still air @ 25 °C) (Still water @ 25 °C)	0.10 mW/°C 0.50 mW/°C	0.12 mW/°C 0.60 mW/°C
THERMAL TIME CONSTANT	(Still air) (Plunge into water)	1.0 sec 14 msec	1.2 sec 16 msec
RESISTANCE RANGE	300 ohm to 10 megohm - see Table B for standard values.		
MAXIMUM POWER RATING	.015 watts max. - 100% of max. power up to 125 °C then derate linearly to 0% at 300 °C.		

Thermobeads Series BR14 and BR16

RESISTANCE VS. TEMPERATURE CHARACTERISTIC - The nominal standard values for the Zero-Power Resistance at 25 °C, R_{25}, are shown in Table B. Also shown are the nominal Resistance Ratio between 25 °C and 125 °C, R_{25}/R_{125}, and the material system code letter (MS).

TABLE B - STANDARD RESISTANCE VALUES*

R_{25} Ω	$\frac{R_{25}}{R_{125}}$	R-T Curve	MS	R_{25} KΩ	$\frac{R_{25}}{R_{125}}$	R-T Curve	MS	R_{25} KΩ	$\frac{R_{25}}{R_{125}}$	R-T Curve	MS	R_{25} KΩ	$\frac{R_{25}}{R_{125}}$	R-T Curve	MS	R_{25} MΩ	$\frac{R_{25}}{R_{125}}$	R-T Curve	MS
				1.0	12.5	2	A	10	19.8	5	A	100	29.4	8	B	1.0	38.1	12	B
				1.1				11				110				1.1			
				1.2				12				120				1.2			
				1.3				13				130	30.8	9		1.3	45.0	13	
				1.5				15				150				1.5			
				1.6	14.0	3		16				160				1.6			
				1.8				18				180				1.8			
				2.0				20				200				2.0			
				2.2				22				220				2.2			
				2.4				24				240	32.3	10		2.4			
				2.7				27				270				2.7			
300				3.0				30				300				3.0			
330				3.3				33				330				3.3			
360				3.6	16.9	4		36				360				3.6			
390				3.9				39				390				3.9			
430	11.8	1		4.3				43	22.7	7	A	430				4.3	48.1	14	
470				4.7				47				470				4.7			
510			A	5.1				51				510	35.7	11		5.1			
560				5.6				56				560				5.6			
620				6.2				62				620				6.2			
680				6.8	19.8	5		68				680				6.8	56.5	15	
750	12.5	2		7.5				75	29.4	8	B	750	38.1	12		7.5			
820				8.2				82				820				8.2			
910				9.1				91				910				9.1			

*The resistance values shown are from the standard 24-value series decade shown in MIL-T-23648. Other values, as well as values specified at other reference temperatures, are available on request.

TABLE 1 - STANDARD TOLERANCES

Tolerance Code Letter	F	G	J	K	L	M	N	P	Q	R	S
± % Tolerance @ 25 °C	1	2	5	10	15	20	25	30	40	50	Non-Standard (Specify value)

ORDERING INFORMATION

The Code Number to be ordered may be specified as follows:

BR _____

- Tolerance code letter per Table 1 (see note 1)
- Zero-power resistance at 25 °C (see note 2)
- Material system code letter (see Table B)
- Lead configuration - "K" denotes adjacent leads with stub ends glass coated; "P" denotes opposite leads with stub ends glass coated
- Bead diameter in mils (specify 14 or 16)
- Style: "BR" denotes a ruggedized bead structure.

Notes: 1) Special tolerances are available on request. To specify a non-standard tolerance, use the letter "S" followed by the desired tolerance (i.e., S3 = ±3%).
2) The zero-power resistance 25 °C, expressed in ohms, is identified by a three digit number. The first two digits represent significant figures, and the last digit specifies the number of zeros to follow.

For example, a 0.016 inch nominal diameter ruggedized THERMOBEAD with adjacent leads, having a zero-power resistance of 2000 Ω, and a tolerance of ±25%, would be specified as BR16KA202N.

THERMOBEADS

SERIES BR23

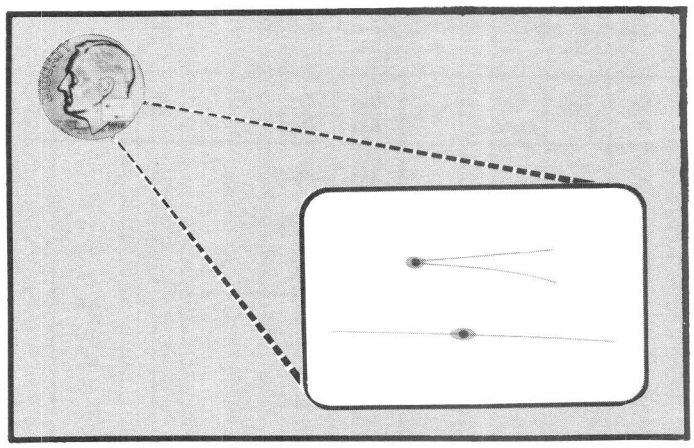
Ruggedized

All ruggedized THERMOBEADS are designed to meet or exceed the performance requirements of MIL-T-23648. Their use is recommended for military applications and commercial applications for which high reliability is a requirement.

STYLE: The series BR23 THERMOBEAD is a ruggedized bead version of the P25 THERMOPROBE. As such, it combines the ruggedness and high reliability of the probe design with the smaller size offered by the bead design. These ruggedized THERMOBEADS exhibit greater stability than conventional glass coated thermistors in that a much better strain relief is provided for the lead wire-glass interface as well as a superior hermetic seal.

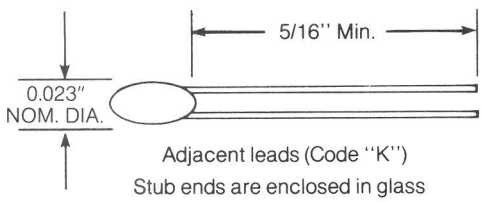
APPLICATIONS: The series BR23 ruggedized THERMOBEADS are ideally suited for applications in which the thermistor lead wires may be inadvertantly tugged. With conventional glass coated bead thermistors, the glass seal may be ruptured and, in some cases, the strain may be transmitted to the lead wire-ceramic interface during assembly operations. The ruggedized THERMOBEADS were developed to eliminate such problems.

MAXIMUM TEMPERATURE: All ruggedized THERMOBEADS are aged at 300 °C for extended periods of time. As such, they exhibit excellent stability for all temperatures at or below 300 °C. Intermittent operation at temperatures up to 600 °C is permissible. When additional pre-conditioning is specified, compliance with the performance requirements of MIL-T-23648 can be guaranteed.

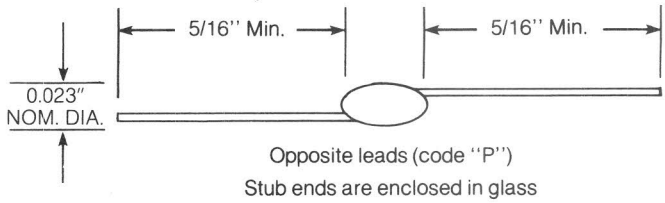


OPTIONS The standard units may be modified to suit the users particular needs by specifying any of the following options:

- Non-standard resistance values.
- Reference temperatures other than 25 °C.
- Non-standard tolerances (at one or more temperatures).
- Longer continuous leads.
- Welded or soldered extension leads - specify lead material, diameter, length, and insulation, if any.
- Tinned leads for improved solderability.
- Special mountings and enclosures.
- Calibration - specify temperature(s).
- Special aging for high reliability applications.
- Interchangeable pairs, sets; curve matching - specify temperature(s) and tolerance(s).



Adjacent leads (Code "K")
Stub ends are enclosed in glass



Opposite leads (code "P")
Stub ends are enclosed in glass

Leads are platinum alloy 0.002" dia.

THERMAL AND ELECTRICAL PROPERTIES

(Definitions and test methods per MIL-T-23648).

		SERIES BR23
DISSIPATION CONSTANT	(Still air @ 25 °C) (Still water @ 25 °C)	0.18 mW/ °C 0.90 mW/ °C
THERMAL TIME CONSTANT	(Still air) (Plunge into water)	1.7 sec 40 msec
RESISTANCE RANGE	300 ohm to 10 megohm - see Table B for standard values.	
MAXIMUM POWER RATING	.020 watts max. - 100% of max. power up to 125 °C then derate linearly to 0% at 300 °C.	

Thermobeads - SERIES BR23

RESISTANCE VS. TEMPERATURE CHARACTERISTIC The nominal standard values for the Zero-Power Resistance at 25 °C, R_{25}, are shown in Table B. Also shown are the nominal Resistance Ratio between 25 °C and 125 °C, R_{25}/R_{125}, and the material system code letter (MS).

TABLE B - STANDARD RESISTANCE VALUES*

R_{25} Ω	$\frac{R_{25}}{R_{125}}$	R-T Curve	MS	R_{25} KΩ	$\frac{R_{25}}{R_{125}}$	R-T Curve	MS	R_{25} KΩ	$\frac{R_{25}}{R_{125}}$	R-T Curve	MS	R_{25} KΩ	$\frac{R_{25}}{R_{125}}$	R-T Curve	MS	R_{25} MΩ	$\frac{R_{25}}{R_{125}}$	R-T Curve	MS
300	11.8	1	A	1.0	12.5	2	A	10	19.8	5	A	100	29.4	8	B	1.0	38.1	12	B
330				1.1				11				110				1.1			
360				1.2				12				120				1.2			
390				1.3				13				130	30.8	9		1.3	45.0	13	
430				1.5				15				150				1.5			
470				1.6	14.0	3		16				160				1.6			
510				1.8				18				180				1.8			
560				2.0				20				200				2.0			
620				2.2				22				220				2.2			
680				2.4				24				240	32.3	10		2.4			
750	12.5	2		2.7				27	22.7	7	A	270				2.7			
820				3.0				30				300				3.0			
910				3.3				33				330				3.3			
				3.6				36				360				3.6			
				3.9	16.9	4		39				390				3.9			
				4.3				43				430	35.7	11		4.3	48.1	14	
				4.7				47				470				4.7			
				5.1				51				510				5.1			
				5.6				56				560				5.6			
				6.2				62				620				6.2			
				6.8				68				680				6.8			
				7.5	19.8	5		75	29.4	8	B	750	38.1	12		7.5	56.5	15	
				8.2				82				820				8.2			
				9.1				91				910				9.1			

*The resistance values shown are from the standard 24-value series decade shown in MIL-T-23648. Other values, as well as values specified at other reference temperatures, are available on request.

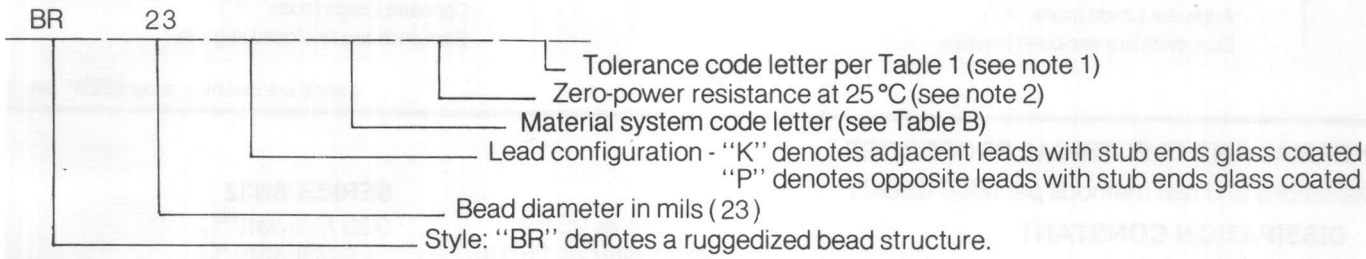
See Curves Pages L-1 and L-2

TABLE 1 - STANDARD TOLERANCES

Tolerance Code Letter	F	G	J	K	L	M	N	P	Q	R	S
± % Tolerance @ 25 °C	1	2	5	10	15	20	25	30	40	50	Non-Standard (Specify value)

ORDERING INFORMATION

The Code Number to be ordered may be specified as follows:



Notes: 1) Special tolerances are available on request. To specify a non-standard tolerance, use the letter "S" followed by the desired tolerance (i.e., S3 = ±3%).
2) The zero-power resistance 25 °C, expressed in ohms, is identified by a three digit number. The first two digits represent significant figures, and the last digit specifies the number of zeros to follow.

For example, a 0.023 inch nominal diameter ruggedized THERMOBEAD with adjacent leads, having a zero-power resistance of 2000 Ω, and a tolerance of ±25%, would be specified as BR23KA202N.

THERMOBEADS

SERIES BR32

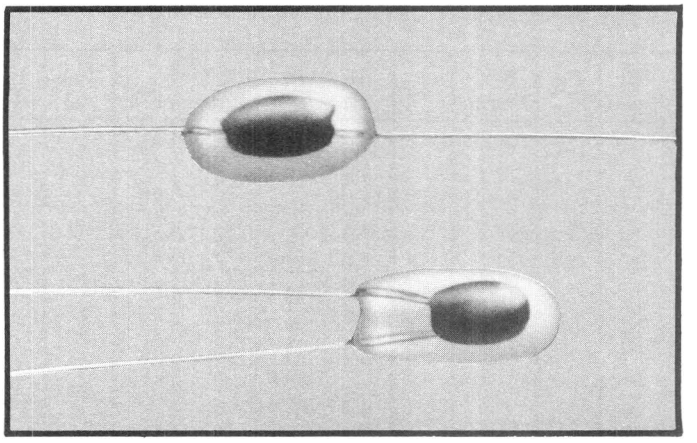
Ruggedized

All ruggedized THERMOBEADS are designed to meet or exceed the performance requirements of MIL-T-23648. Their use is recommended for military applications as well as low cost high reliability applications.

STYLE: The series BR32 THERMOBEAD is a ruggedized bead version of the series P30 THERMOPROBE. As such, it combines the ruggedness and high reliability of the probe design with the smaller size offered by the bead design. The series BR32 THERMOBEAD exhibits greater stability than conventional glass coated bead thermistors in that the ruggedized glass version provides better strain relief for the lead wire-glass interface, as well as a superior hermetic seal.

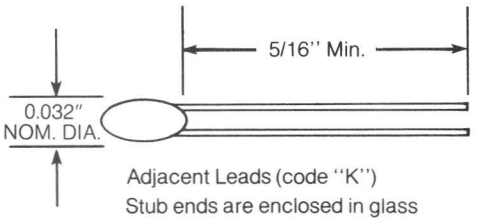
APPLICATIONS: The series BR32 THERMOBEADS are ideally suited for assembly operations in which the thermistor lead wires may be inadvertantly tugged. With normal glass coated bead thermistors the glass seal may be ruptured during assembly operations and, in some cases, the strain may be transmitted to the lead wire - ceramic interface. The series BR32 THERMOBEADS were developed to eliminate such problems.

MAXIMUM TEMPERATURE: All THERMOBEADS are aged at 300 °C for extended periods of time. As such, they exhibit excellent stability for all service temperatures at or below 300 °C. Intermittent operation at temperatures up to 600 °C is permissible. When additional pre-conditioning is specified, compliance with the performance requirements of MIL-T-23648 can be guaranteed.

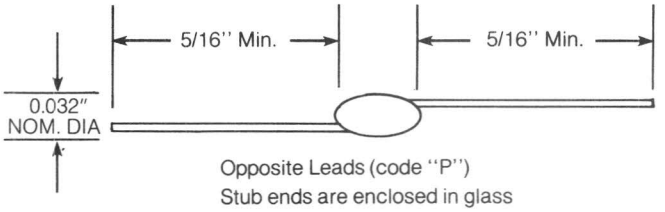


OPTIONS - Standard units may be modified to suit the users particular needs by specifying any of the following options:

- Non standard resistance values
- Non standard tolerance(s)
- Reference temperature(s) other than 25 °C
- Longer continuous leads
- Tinned leads for greatly improved solderability
- Welded or soldered extension leads - specify lead and insulation material, and dimensions, if any.
- Special mountings and enclosures
- Calibration - specify temperature(s)
- Special aging for high reliability applications
- Interchangeable pairs, sets; curve matching - specify temperature(s) and tolerance(s)



Adjacent Leads (code "K")
Stub ends are enclosed in glass



Opposite Leads (code "P")
Stub ends are enclosed in glass

Leads are platinum alloy 0.003" dia.

THERMAL AND ELECTRICAL PROPERTIES

(Definitions and test methods per MIL-T-23648)

		SERIES BR32
DISSIPATION CONSTANT	(Still air @ 25 °C)	0.28 Milliwatt/ °C
	(Still water @ 25 °C)	1.4 Milliwatt/ °C
THERMAL TIME CONSTANT	(Still air)	4.5 Seconds
	(Plunge into water)	90 Milliseconds
RESISTANCE RANGE	100 Ohms to 10 Megohms - see Table D for standard values.	
MAXIMUM POWER RATING	.035 Watts max. - Derating curve; 100% of max. power to 150° C linearly derated to 0% at 300 °C.	

Thermobeads - Series BR32

RESISTANCE VS. TEMPERATURE CHARACTERISTIC - The nominal standard values for the Zero-Power Resistance at 25 °C, R_{25}, are shown in Table D. Also shown are the nominal Resistance Ratio between 25 °C and 125 °C, R_{25}/R_{125}, and the material system code letter (MS).

TABLE D - STANDARD RESISTANCE VALUES*

R_{25} Ω	$\frac{R_{25}}{R_{125}}$	R-T Curve	MS	R_{25} KΩ	$\frac{R_{25}}{R_{125}}$	R-T Curve	MS	R_{25} KΩ	$\frac{R_{25}}{R_{125}}$	R-T Curve	MS	R_{25} KΩ	$\frac{R_{25}}{R_{125}}$	R-T Curve	MS	R_{25} MΩ	$\frac{R_{25}}{R_{125}}$	R-T Curve	MS
100	11.8	1	A	1.0	14.0	3	A	10	22.1	6	A	100	32.3	10	B	1.0	45.0	13	B
110				1.1				11				110				1.1			
120				1.2				12				120				1.2			
130				1.3				13	22.7	7	A	130				1.3			
150				1.5				15				150	35.7	11		1.5	48.1	14	
160				1.6				16				160				1.6			
180				1.8				18				180				1.8			
200				2.0	16.9	4		20				200				2.0			
220				2.2				22				220				2.2			
240				2.4				24				240				2.4			
270				2.7				27				270				2.7			
300	12.5	2		3.0	19.8	5		30	29.4	8		300	38.1	12		3.0	56.5	15	
330				3.3				33				330				3.3			
360				3.6				36				360				3.6			
390				3.9				39				390				3.9			
430				4.3				43			B	430				4.3			
470				4.7				47				470				4.7			
510				5.1				51	30.8	9		510				5.1			
560				5.6				56				560				5.6			
620				6.2				62				620				6.2			
680				6.8				68				680				6.8			
750	14.0	3		7.5	22.1	6		75	32.3	10		750	45.0	13		7.5	75.6	16	D
820				8.2				82				820				8.2			
910				9.1				91				910				9.1			

*The resistance values shown are from the standard 24-value series decade shown in MIL-T-23648. Other values, as well as values specified at other reference temperatures, are available on request.

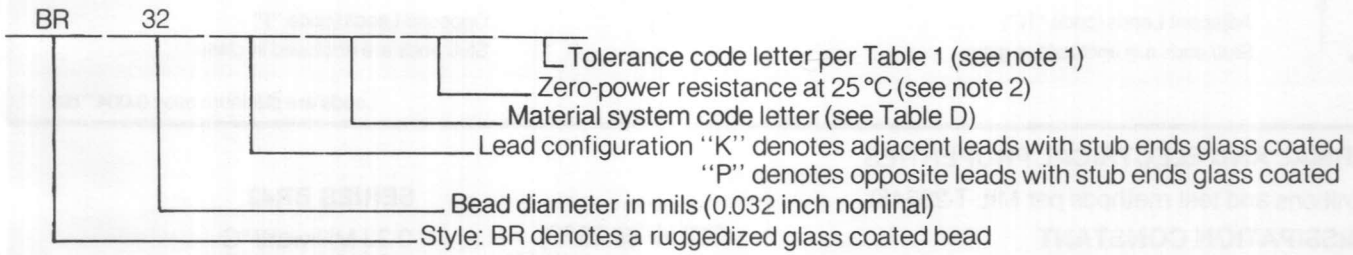
See Curves Pages L-1 and L-2

TABLE 1 - STANDARD TOLERANCES

Tolerance Code Letter	F	G	J	K	L	M	N	P	Q	R	S
±% Tolerance @ 25°C	1	2	5	10	15	20	25	30	40	50	Non-Standard (Specify value)

ORDERING INFORMATION

The Code Number to be ordered may be specified as follows:



Notes: 1) Special tolerances are available on request. To specify a non-standard tolerance, use the letter "S" followed by the desired tolerance (i.e., S3 = ± 3%).

2) The zero-power resistance at 25 °C, expressed in ohms, is identified by a three digit number. The first two digits represent significant figures, and the last digit specifies the number of zeros to follow.

For example, a 0.032 inch nominal diameter glass coated THERMOBEAD with opposite leads, having a zero power resistance at 25 °C of 2000 Ω , and a tolerance of ± 20%, would be specified as BR32PA202M.

THERMOBEADS

SERIES BR42

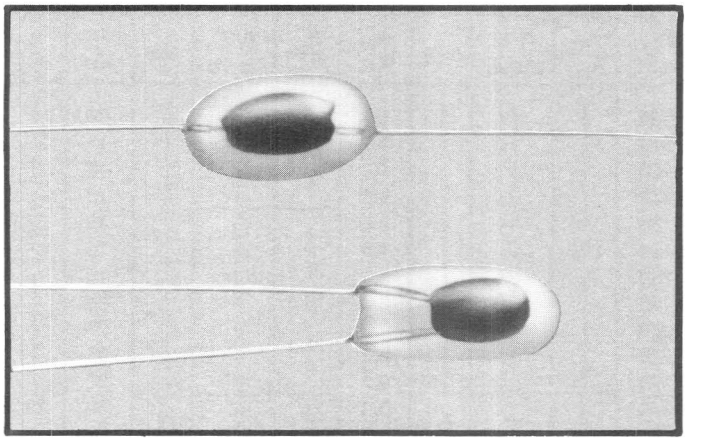
Ruggedized

All ruggedized THERMOBEADS are designed to meet or exceed the performance requirements of MIL-T-23648. Their use is recommended for military applications as well as low cost high reliability applications.

STYLE: The series BR42 THERMOBEAD is a ruggedized bead version of the glass coated bead thermistor series B35. The series BR42 THERMOBEAD exhibits better stability than its glass coated counterpart in that a much better strain relief is provided for the lead wire-glass interface, as well as a much better hermetic seal.

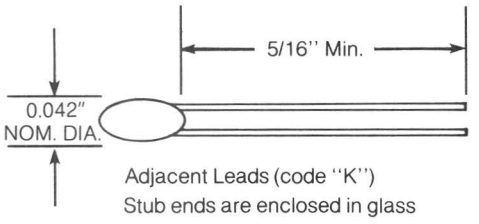
APPLICATIONS: The series BR42 THERMOBEADS are ideally suited for assembly operations in which the thermistor lead wires may be inadvertantly tugged. With normal glass coated bead thermistors the glass seal may be ruptured during assembly operations and, in some cases, the strain may be transmitted to the lead wire - ceramic interface. The series BR42 THERMOBEADS were developed to eliminate such problems.

MAXIMUM TEMPERATURE: All THERMOBEADS are aged at 300 °C for extended periods of time. As such, they exhibit excellent stability for all service temperatures at or below 300 °C. Intermittent operation at temperatures up to 600 °C is permissible. When additional pre-conditioning is specified, compliance with the performance requirements of MIL-T-23648 can be guaranteed.

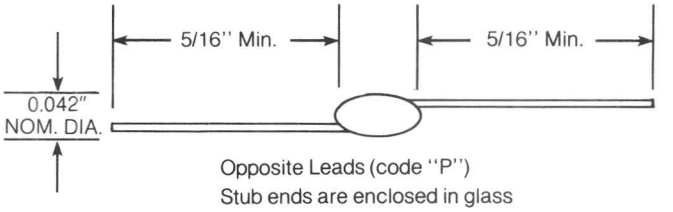


OPTIONS - Standard units may be modified to suit the users particular needs by specifying any of the following options:

- Non standard resistance values
- Non standard tolerance(s)
- Reference temperature(s) other than 25 °C
- Longer continuous leads
- Tinned leads for greatly improved solderability
- Welded or soldered extension leads - specify lead and insulation material, and dimensions, if any.
- Special mountings and enclosures
- Calibration - specify temperature(s)
- Special aging for high reliability applications
- Interchangeable pairs, sets; curve matching - specify temperature(s) and tolerance(s)



Adjacent Leads (code "K")
Stub ends are enclosed in glass



Opposite Leads (code "P")
Stub ends are enclosed in glass

Leads are platinum alloy 0.004" dia.

THERMAL AND ELECTRICAL PROPERTIES

(Definitions and test methods per MIL-T-23648)

		SERIES BR42
DISSIPATION CONSTANT	(Still air @ 25 °C)	0.33 Milliwatt/ °C
	(Still water @ 25 °C)	1.65 Milliwatt/ °C
THERMAL TIME CONSTANT	(Still air)	5 Seconds
	(Plunge into water)	140 Milliseconds
RESISTANCE RANGE		30 Ohms to 20 Megohms - see Table C for standard values.
MAXIMUM POWER RATING		.042 Watts max. - Derating curve; 100% of max. power to 150° C linearly derated to 0% at 300 °C.

Thermobeads - Series BR42

RESISTANCE VS. TEMPERATURE CHARACTERISTIC - The nominal standard values for the Zero-Power Resistance at 25 °C, R_{25}, are shown in Table C. Also shown are the nominal Resistance Ratio between 25 °C and 125 °C, R_{25}/R_{125}, and the material system code letter (MS).

TABLE C - STANDARD RESISTANCE VALUES*

R_{25} Ω	$\frac{R_{25}}{R_{125}}$	R-T Curve	MS	R_{25} Ω	$\frac{R_{25}}{R_{125}}$	R-T Curve	MS	R_{25} KΩ	$\frac{R_{25}}{R_{125}}$	R-T Curve	MS	R_{25} KΩ	$\frac{R_{25}}{R_{125}}$	R-T Curve	MS	R_{25} KΩ	$\frac{R_{25}}{R_{125}}$	R-T Curve	MS	R_{25} MΩ	$\frac{R_{25}}{R_{125}}$	R-T Curve	MS
30	5.0		E	300	12.5	2	A	3.0	19.8	5	A	30	30.8	9	B	300	38.1	12	B	3.0	75.6	16	D
33				330				3.3				33				330				3.3			
36				360				3.6				36				360				3.6			
39				390				3.9				39				390				3.9			
43				430				4.3	22.1	6		43				430				4.3			
47				470	14.0	3		4.7				47	32.3	10		470	45.0	13		4.7			
51		1		510				5.1				51				510				5.1			
56				560				5.6				56				560				5.6			
62				620				6.2	22.7	7	A	62				620				6.2			
68				680				6.8				68				680				6.8			
75				750				7.5				75				750				7.5			
82	11.8			820				8.2				82				820				8.2			
91				910	16.9	4		9.1				91				910	48.1	14		9.1			
100				1000				10				100	35.7	11		1000				10.0			
110				1100				11				110				1100				11.0			
120			A	1200				12				120				1200				12.0			
130				1300				13				130				1300				13.0			
150				1500				15	29.4	8	B	150				1500				15.0	81.0		
160				1600				16				160				1600				16.0			
180				1800				18				180				1800	56.5	15		18.0			
200	12.5	2		2000	19.8	5		20				200	38.1	12		2000				20.0			
220				2200				22				220				2200							
240				2400				24				240				2400							
270				2700				27	30.8	9		270				2700							

*The resistance values shown are from the standard 24-value series decade shown in MIL-T-23648. Other values, as well as values specified at other reference temperatures, are available on request.

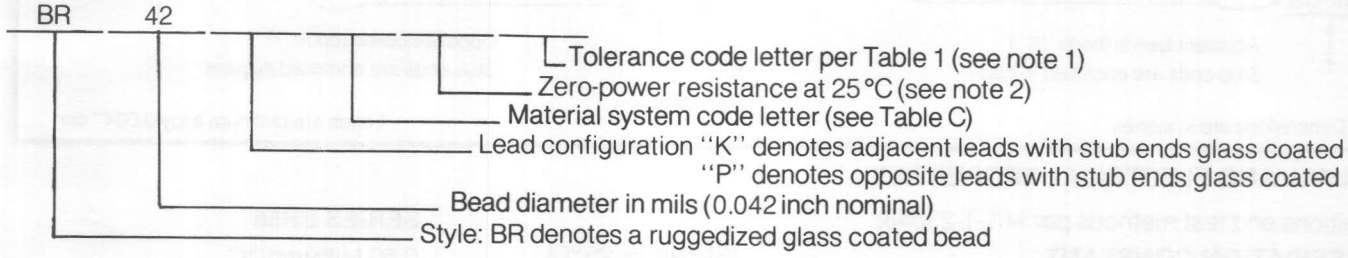
See Curves Pages L-1 and L-2

TABLE 1 - STANDARD TOLERANCES

Tolerance Code Letter	F	G	J	K	L	M	N	P	Q	R	S
±% Tolerance @ 25°C	1	2	5	10	15	20	25	30	40	50	Non-Standard (Specify value)

ORDERING INFORMATION

The Code Number to be ordered may be specified as follows:



Notes: 1) Special tolerances are available on request. To specify a non-standard tolerance, use the letter "S" followed by the desired tolerance (i.e., S3 = ± 3%).
2) The zero-power resistance at 25 °C, expressed in ohms, is identified by a three digit number. The first two digits represent significant figures, and the last digit specifies the number of zeros to follow.
For example, a 0.042 inch nominal diameter glass coated THERMOBEAD with opposite leads, having a zero power resistance at 25 °C of 2000 Ω , and a tolerance of ± 20%, would be specified as BR42PA202M.

THERMOBEADS

SERIES BR55

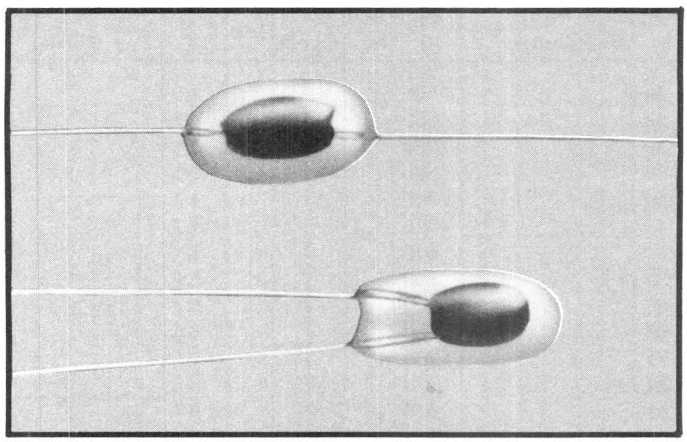
Ruggedized

All ruggedized THERMOBEADS are designed to meet or exceed the performance requirements of MIL-T-23648. Their use is recommended for military applications as well as low cost high reliability applications.

STYLE: The series BR55 THERMOBEAD is a ruggedized bead version of the series P60 THERMOPROBE. As such, it combines the ruggedness and high reliability of the probe design with the smaller size offered by the bead design. The series BR55 THERMOBEAD, exhibits greater stability than the series B43 glass coated THERMOBEAD, in that a much better strain relief is provided for the lead wire - glass interface, as well as a superior hermetic seal.

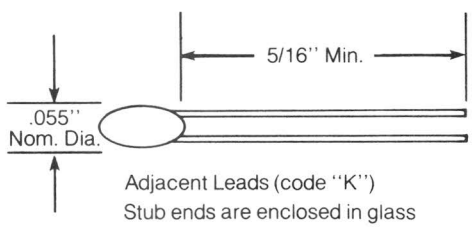
APPLICATIONS: The series BR55 THERMOBEADS are ideally suited for assembly operations in which the thermistor lead wires may be inadvertantly tugged. With normal glass coated bead thermistors the glass seal may be ruptured during assembly operations and, in some cases, the strain may be transmitted to the lead wire - ceramic interface. The series BR55 THERMOBEADS were developed to eliminate such problems.

MAXIMUM TEMPERATURE: All THERMOBEADS are aged at 300 °C for extended periods of time. As such, they exhibit excellent stability for all service temperatures at or below 300 °C. Intermittent operation at temperatures up to 600 °C is permissible. When additional pre-conditioning is specified, compliance with the performance requirements of MIL-T-23648 can be guaranteed.

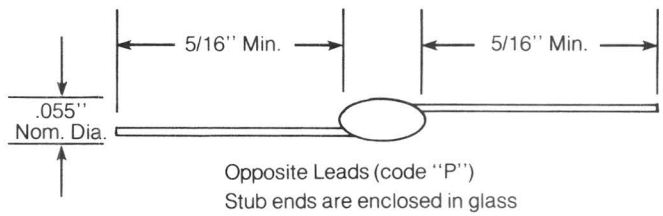


OPTIONS - Standard units may be modified to suit the users particular needs by specifying any of the following options:

- Non standard resistance values
- Non standard tolerance(s)
- Reference temperature(s) other than 25 °C
- Longer continuous leads
- Tinned leads for greatly improved solderability
- Welded or soldered extension leads - specify lead and insulation material, and dimensions, if any.
- Special mountings and enclosures
- Calibration - specify temperature(s)
- Special aging for high reliability applications
- Interchangeable pairs, sets; curve matching - specify temperature(s) and tolerance(s)



Adjacent Leads (code "K")
Stub ends are enclosed in glass



Opposite Leads (code "P")
Stub ends are enclosed in glass

All Dimensions are in inches

Leads are platinum alloy 0.004" dia.

THERMAL AND ELECTRICAL PROPERTIES

(Definitions and test methods per MIL-T-23648)

		SERIES BR55
DISSIPATION CONSTANT	(Still air @ 25 °C)	0.50 Milliwatt/ °C
	(Still water @ 25 °C)	2.50 Milliwatt/ °C
THERMAL TIME CONSTANT	(Still air)	7 Seconds
	(Plunge into water)	200 Milliseconds
RESISTANCE RANGE	30 Ohms to 20 Megohms - see Table C for standard values.	
MAXIMUM POWER RATING	.050 Watts max. - Derating curve; 100% of max. power to 200 °C linearly derated to 0% at 300 °C.	

Thermobeads - Series BR55

RESISTANCE VS. TEMPERATURE CHARACTERISTIC - The nominal standard values for the Zero-Power Resistance at 25 °C, R_{25}, are shown in Table C. Also shown are the nominal Resistance Ratio between 25 °C and 125 °C, R_{25}/R_{125}, and the material system code letter (MS).

TABLE C - STANDARD RESISTANCE VALUES*

R_{25} Ω	$\frac{R_{25}}{R_{125}}$	R-T Curve	MS	R_{25} Ω	$\frac{R_{25}}{R_{125}}$	R-T Curve	MS	R_{25} KΩ	$\frac{R_{25}}{R_{125}}$	R-T Curve	MS	R_{25} KΩ	$\frac{R_{25}}{R_{125}}$	R-T Curve	MS	R_{25} KΩ	$\frac{R_{25}}{R_{125}}$	R-T Curve	MS	R_{25} MΩ	$\frac{R_{25}}{R_{125}}$	R-T Curve	MS
30	5.0		E	300	12.5	2	A	3.0	19.8	5	A	30	30.8	9	B	300	38.1	12	B	3.0	75.6	16	D
33				330				3.3				33				330				3.3			
36				360				3.6				36				360				3.6			
39				390				3.9				39				390				3.9			
43				430				4.3	22.1	6		43	32.3	10		430	45.0	13		4.3			
47				470	14.0	3		4.7				47				470				4.7			
51				510				5.1				51				510				5.1			
56				560				5.6				56				560				5.6			
62				620				6.2				62				620				6.2			
68				680				6.8	22.7	7	A	68				680				6.8			
75				750				7.5				75				750				7.5			
82	11.8	1		820				8.2				82				820				8.2			
91				910				9.1				91				910	48.1	14		9.1			
100				1000	16.9	4		10				100	35.7	11		1000				10.0			
110				1100				11				110				1100				11.0			
120				1200				12				120				1200				12.0			
130				1300				13				130				1300				13.0	81.0		
150				1500				15	29.4	8	B	150				1500	56.5	15		15.0			
160				1600				16				160				1600				16.0			
180				1800				18				180				1800				18.0			
200	12.5	2		2000	19.8	5		20				200	38.1	12		2000				20.0			
220				2200				22				220				2200							
240				2400				24				240				2400							
270				2700				27	30.8	9		270				2700							

*The resistance values shown are from the standard 24-value series decade shown in MIL-T-23648. Other values, as well as values specified at other reference temperatures, are available on request.

See Curves Pages L-1 and L-2

TABLE 1 - STANDARD TOLERANCES

Tolerance Code Letter	F	G	J	K	L	M	N	P	Q	R	S
±% Tolerance @ 25°C	1	2	5	10	15	20	25	30	40	50	Non-Standard (Specify value)

ORDERING INFORMATION

The Code Number to be ordered may be specified as follows:

BR 55 ____ ____ ____ ____ ____

- ____ Tolerance code letter per Table 1 (see note 1)
- ____ Zero-power resistance at 25 °C (see note 2)
- ____ Material system code letter (see Table C)
- ____ Lead configuration "K" denotes adjacent leads with stub ends glass coated
  "P" denotes opposite leads with stub ends glass coated
- 55 Bead diameter in mils (0.055 inch nominal)
- BR Style: BR denotes a ruggedized glass coated bead

Notes: 1) Special tolerances are available on request. To specify a non-standard tolerance, use the letter "S" followed by the desired tolerance (i.e., S3 = ± 3%).

2) The zero-power resistance at 25 °C, expressed in ohms, is identified by a three digit number. The first two digits represent significant figures, and the last digit specifies the number of zeros to follow.
For example, a 0.055 inch nominal diameter glass coated THERMOBEAD with opposite leads, having a zero power resistance at 25 °C of 2000 Ω , and a tolerance of ± 20%, would be specified as BR55PA202M.

PROBES & RODS

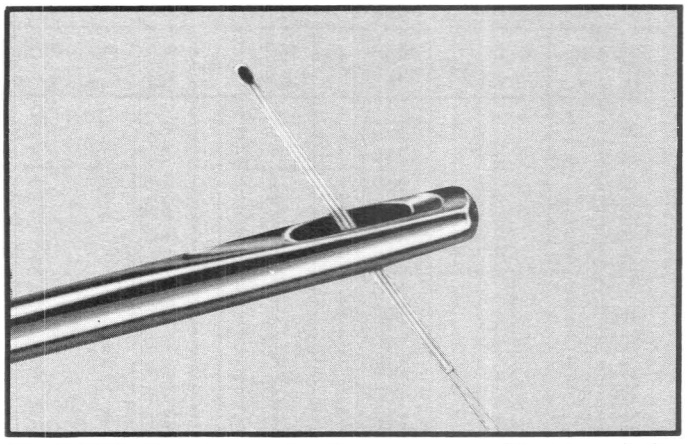
SERIES P20 and P25

All miniature THERMOPROBES are designed to meet or exceed the performance requirements of MIL-T-23648.

STYLE: The series P20 and P25 miniature THERMOPROBES consist of a small bead thermistor hermetically sealed in the tip of a shock resistant solid glass rod. These units are rugged and unaffected by severe environmental exposures, including high density nuclear radiation. They exhibit excellent long term stability.

APPLICATIONS: The series P20 and P25 miniature THERMOPROBES feature high reliability, stability, easy handling, and very fast thermal response times. Their use is recommended for assemblies incorporating small housings, needles and catheter tubes. They are particularly well suited for immersion in fluids where fast response is a major requirement. The nominal diameters of the P20 and P25 THERMOPROBES are 0.020 and 0.025 inches respectively.

MAXIMUM TEMPERATURE: The series P20 and P25 THERMOPROBES are aged at 300 °C for extended periods of time. As such, they exhibit excellent stability for all temperatures at or below 300 °C. Intermittent operation at temperatures up to 600 °C is permissible. When additional pre-conditioning is specified, compliance with the performance requirements of MIL-T-23648 can be guaranteed.



OPTIONS: The standard units may be modified to suit the users particular needs by specifying any of the following options.

- Non-standard resistance values.
- Non-standard sizes.
- Reference temperature(s) other than 25 °C.
- Non-standard tolerances (at one or more temperatures).
- Tinned leads for improved solderability.
- Longer or shorter leads.
- Extension leads - specify lead, material, diameter, length, and insulation, if any. Also specify if moisture proof seal is desired over joint.
- Special mountings and enclosures.
- Calibration - specify temperature(s).
- Interchangeable pairs, sets: curve matching - specify temperature(s) and tolerance(s).

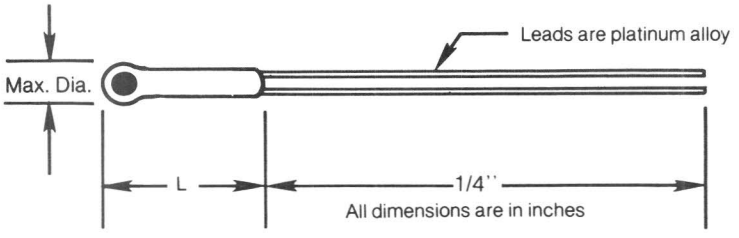


Table 1 - Standard Sizes of Series P20 and P25 THERMOPROBES

Dimension	Series P20			Series P25	
Max. Dia.	0.020"			0.025"	
L	1/16"	1/8"	1/4"	1/8"	1/4"
Lead Diameter	0.001"		0.002"	0.002"	

THERMAL AND ELECTRICAL PROPERTIES

(Definitions and test methods per MIL-T-23648)

		SERIES P20	SERIES P25
DISSIPATION CONSTANT	(Still air @ 25 °C) (Still water @ 25 °C)	0.14 mW/ °C 0.70 mW/ °C	0.16 mW/ °C 0.80 mW/ °C
THERMAL TIME CONSTANT	(Still air) (Plunge into water)	1.6 sec 18 msec	2.0 sec 23 msec
RESISTANCE RANGE	300 ohm to 10 megohm - see Table B for standard values.		
MAXIMUM POWER RATING	100 % of max. power up to 150 °C then derate linearly to 0 % power at 300 °C.	.020 watts	.025 watts

Probes & Rods - Series P20 and P25

RESISTANCE VS. TEMPERATURE CHARACTERISTIC - The nominal standard values for the Zero-Power Resistance at 25 °C, R_{25}, are shown in Table B. Also shown are the nominal Resistance Ratio between 25 °C and 125 °C, R_{25} / R_{125}, and the material system code letter (MS).

TABLE B - STANDARD RESISTANCE VALUES*

R_{25} Ω	$\frac{R_{25}}{R_{125}}$	R-T Curve	MS	R_{25} KΩ	$\frac{R_{25}}{R_{125}}$	R-T Curve	MS	R_{25} KΩ	$\frac{R_{25}}{R_{125}}$	R-T Curve	MS	R_{25} KΩ	$\frac{R_{25}}{R_{125}}$	R-T Curve	MS	R_{25} MΩ	$\frac{R_{25}}{R_{125}}$	R-T Curve	MS
300	11.8	1	A	1.0	12.5	2	A	10	19.8	5	A	100	29.4	8	B	1.0	38.1	12	B
330				1.1				11				110				1.1			
360				1.2				12				120				1.2			
390				1.3				13				130	30.8	9		1.3	45.0	13	
430				1.5				15				150				1.5			
470				1.6	14.0	3		16				160				1.6			
510				1.8				18				180				1.8			
560				2.0				20				200				2.0			
620				2.2				22				220				2.2			
680				2.4				24				240	32.3	10		2.4			
750				2.7				27				270				2.7			
820				3.0				30				300				3.0			
910				3.3				33				330				3.3			
				3.6				36				360				3.6			
				3.9				39				390				3.9			
				4.3				43	22.7	7	A	430				4.3	48.1	14	
				4.7	16.9	4		47				470				4.7			
				5.1				51				510	35.7	11		5.1			
				5.6				56				560				5.6			
				6.2				62				620				6.2			
				6.8				68				680				6.8			
				7.5	19.8	5		75				750				7.5	56.5	15	
				8.2				82	29.4	8	B	820	38.1	12		8.2			
				9.1				91				910				9.1			

*The resistance values shown are from the standard 24-value series decade shown in MIL-T-23648. Other values, as well as values specified at other reference temperatures, are available on request.

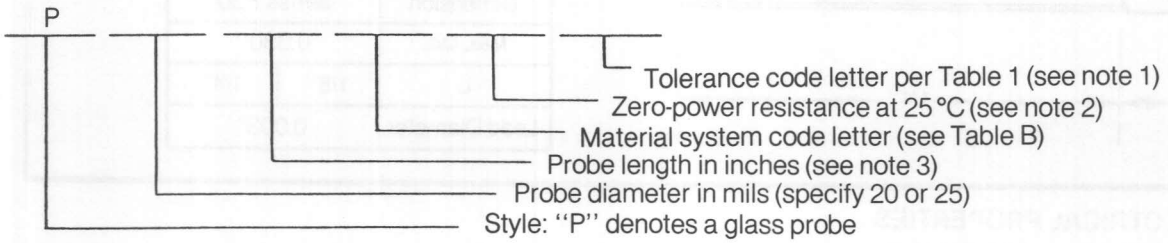
See Curves Pages L-1 and L-2

TABLE 1 - STANDARD TOLERANCES

Tolerance Code Letter	F	G	J	K	L	M	N	P	Q	R	S
± % Tolerance @ 25° C	1	2	5	10	15	20	25	30	40	50	Non-Standard (Specify value)

ORDERING INFORMATION

The Code Number to be ordered may be specified as follows:



Notes: 1) Special tolerances are available on request. To specify a non-standard tolerance, use the letter "S" followed by the desired tolerance (i.e., S0.5 = ±0.5%).

2) The zero-power resistance at 25 °C, expressed in ohms, is identified by a three digit number. The first two digits represent signifcant figures, and the last digit specifies the number of zeros to follow.

3) The nominal probe length, in inches, is specified by a letter, as follows:

NOMINAL PROBE LENGTH	1/16	1/8	1/4
ORDERING CODE LETTER	AA	A	B

(see Table 1 for available sizes)

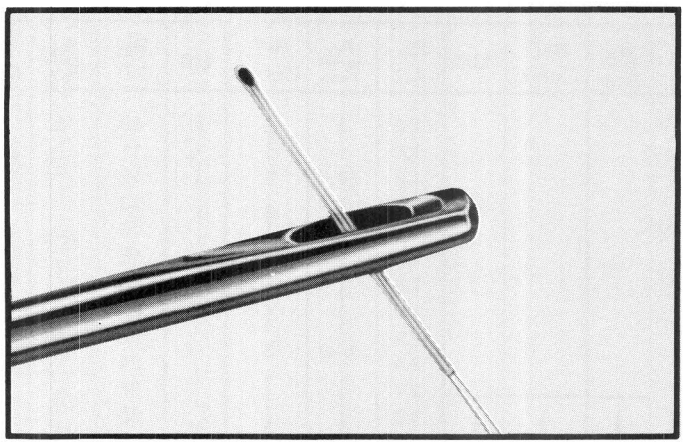
For example a 0.020 inch max. diameter x 1/4 inch long glass probe, with a zero-power resistance at 25 °C of 2000 Ω, and a tolerance of ±20%, would be specified as P20BA202M.

SERIES P30

All miniature THERMOPROBES are designed to meet or exceed the performance requirements of MIL-T-23648.

STYLE: The series P30 miniature THERMOPROBES consist of small bead thermistors hermetically sealed in the tips of shock resistant solid glass rods. These units are rugged and unaffected by severe environmental exposures, including high density nuclear radiation. They exhibit excellent long term stability.

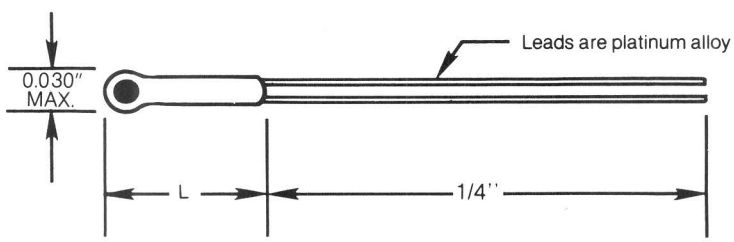
APPLICATIONS: The series P30 miniature THERMOPROBES feature high reliability, stability, easy handling, and very fast thermal response times. Their use is recommended for assemblies incorporating small housings, needles and catheter tubes. They are particularly well suited for immersion in fluids where fast response is a major requirement.



MAXIMUM TEMPERATURE: The series P30 THERMOPROBES are aged at 300 °C for extended periods of time. As such, they exhibit excellent stability for all temperatures at or below 300 °C. Intermittent operation at temperatures up to 600 °C is permissible. When additional pre-conditioning is specified, compliance with the performance requirements of MIL-T-23648 can be guaranteed.

OPTIONS: The standard units may be modified to suit the users particular needs by specifying any of the following options.

- Non-standard resistance values.
- Non-standard sizes.
- Reference temperature(s) other than 25 °C.
- Non-standard tolerances (at one or more temperatures).
- Tinned leads for improved solderability.
- Longer or shorter leads.
- Extension leads - specify lead, material, diameter, length, and insulation, if any. Also specify if moisture proof seal is desired over joint.
- Special mountings and enclosures.
- Calibration - specify temperature(s).
- Interchangeable pairs, sets: curve matching - specify temperature(s) and tolerance(s).



Standard Sizes of
Series P30 THERMOPROBES

Dimension	Series P30	
Max. Dia.	0.030"	
L	1/8"	1/4"
Lead Diameter	0.003"	

THERMAL AND ELECTRICAL PROPERTIES

(Definitions and test methods per MIL-T-23648)

DISSIPATION CONSTANT	(Still air @ 25 °C) (Still water @ 25 °C)	.30 mW/°C 1.5 mW/°C
THERMAL TIME CONSTANT	(Still air) (Plunge into water)	3.0 sec 60 msec
RESISTANCE RANGE	100 ohm to 10 megohm - see Table D for standard values.	
MAXIMUM POWER RATING	100% of max. power up to 150 °C then derate linearly to 0% power at 300 °C.	.035 watts

Probes & Rods - SERIES P30

RESISTANCE VS. TEMPERATURE CHARACTERISTIC - The nominal standard values for the Zero-Power Resistance at 25 °C, R_{25}, are shown in Table D. Also shown are the nominal Resistance Ratio between 25 °C and 125 °C, R_{25} / R_{125}, and the material system code letter (MS).

TABLE D - STANDARD RESISTANCE VALUES*

R_{25} Ω	$\frac{R_{25}}{R_{125}}$	R-T Curve	MS	R_{25} KΩ	$\frac{R_{25}}{R_{125}}$	R-T Curve	MS	R_{25} KΩ	$\frac{R_{25}}{R_{125}}$	R-T Curve	MS	R_{25} KΩ	$\frac{R_{25}}{R_{125}}$	R-T Curve	MS	R_{25} MΩ	$\frac{R_{25}}{R_{125}}$	R-T Curve	MS
100				1.0				10				100				1.0			
110				1.1				11				110				1.1			
120				1.2	14.0	3		12	22.1	6	A	120	32.3	10		1.2	45.0	13	
130				1.3				13				130				1.3			
150				1.5				15	22.7	7	A	150				1.5			
160	11.8	1		1.6				16				160				1.6			
180				1.8				18				180				1.8			
200				2.0	16.9	4		20				200	35.7	11		2.0	48.1	14	
220				2.2				22				220				2.2			
240				2.4				24				240			B	2.4			
270				2.7				27				270				2.7			B
300			A	3.0			A	30	29.4	8		300				3.0			
330				3.3				33				330				3.3			
360				3.6				36				360				3.6			
390				3.9				39				390				3.9			
430	12.5	2		4.3	19.8	5		43			B	430	38.1	12		4.3	56.5	15	
470				4.7				47				470				4.7			
510				5.1				51				510				5.1			
560				5.6				56				560				5.6			
620				6.2				62	30.8	9		620				6.2			
680				6.8				68				680				6.8			
750				7.5	22.1	6		75				750	45.0	13		7.5	75.6	16	D
820	14.0	3		8.2				82	32.3	10		820				8.2			
910				9.1				91				910				9.1			

*The resistance values shown are from the standard 24-value series decade shown in MIL-T-23648. Other values, as well as values specified at other reference temperatures, are available on request.

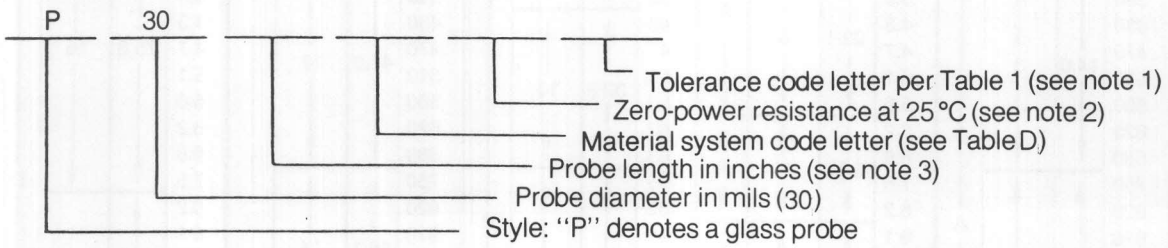
See Curves Pages L-1 and L-2

TABLE 1 - STANDARD TOLERANCES

Tolerance Code Letter	F	G	J	K	L	M	N	P	Q	R	S
± % Tolerance @ 25° C	1	2	5	10	15	20	25	30	40	50	Non-Standard (Specify value)

ORDERING INFORMATION

The Code Number to be ordered may be specified as follows:



Notes: 1) Special tolerances are available on request. To specify a non-standard tolerance, use the letter "S" followed by the desired tolerance (i.e., S0.5 = ±0.5%).

2) The zero-power resistance at 25 °C, expressed in ohms, is identified by a three digit number. The first two digits represent signifcant figures, and the last digit specifies the number of zeros to follow.

3) The nominal probe length, in inches, is specified by a letter, as follows:

NOMINAL PROBE LENGTH	1/8	1/4
ORDERING CODE LETTER	A	B

(see Table 1 for available sizes)

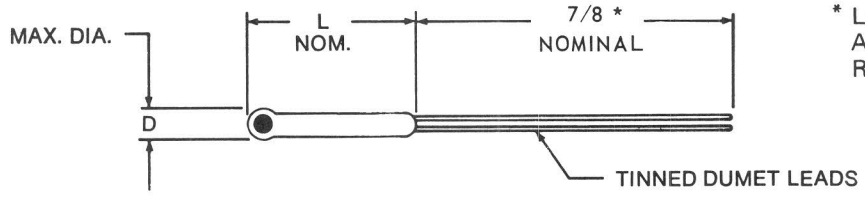
For example a 0.030 inch max. diameter x 1/4 inch long glass probe, with a zero-power resistance at 25 °C of 2000 Ω, and a tolerance of ±20%, would be specified as P30BA202M.

PROBES & RODS

SERIES P60, P65, P85, and P100

All THERMOPROBES are designed to meet or exceed the performance requirements of MIL-T-23648.

The THERMOPROBE consists of a bead thermistor hermetically sealed in the tip of a shock resistant glass rod. These units are rugged and unaffected by severe environmental exposures, including high density nuclear radiation. They exhibit excellent long term stability.



* Longer Leads Available On Request

TABLE 2 STANDARD SIZES OF SERIES P60, P65, P85 and P100 THERMOPROBES

DIMENSIONS	SERIES P60	SERIES P65	SERIES P85	SERIES P100
D	0.060	0.065	0.085	0.100
L	1/8 to 1/2	1/8 to 1/2	1/8 to 1	1/8 to 2
LEAD DIAMETER	0.008	0.008	0.012	0.012

All dimensions are in inches.

RESISTANCE VS. TEMPERATURE CHARACTERISTIC — The nominal standard values for the Zero-Power Resistance at 25 °C, R_{25}, are shown in Table C. Also shown are the nominal Resistance Ratio between 25 °C and 125 °C, R_{25}/R_{125}, and the material system code letter (MS).

TABLE C - STANDARD RESISTANCE VALUES*

R_{25} Ω	$\frac{R_{25}}{R_{125}}$	R-T Curve	MS	R_{25} Ω	$\frac{R_{25}}{R_{125}}$	R-T Curve	MS	R_{25} KΩ	$\frac{R_{25}}{R_{125}}$	R-T Curve	MS	R_{25} KΩ	$\frac{R_{25}}{R_{125}}$	R-T Curve	MS	R_{25} KΩ	$\frac{R_{25}}{R_{125}}$	R-T Curve	MS	R_{25} MΩ	$\frac{R_{25}}{R_{125}}$	R-T Curve	MS
30				300				3.0				30				300				3.0			
33				330	12.5	2		3.3				33				330	38.1	12		3.3			
36				360				3.6	19.8	5		36				360				3.6			
39	5.0		E	390				3.9				39	30.8	9		390				3.9			
43				430				4.3	22.1	6	A	43				430				4.3			
47				470	14.0	3		4.7				47				470	45.0	13		4.7	75.6	16	
51				510				5.1				51	32.3	10		510				5.1			
56				560				5.6				56				560				5.6			
62				620				6.2	22.7	7	A	62				620				6.2			
68				680				6.8				68				680				6.8			
75				750				7.5				75				750				7.5			D
82	11.8	1		820	16.9	4		8.2				82				820	48.1	14		8.2			
91				910				9.1				91			B	910			B	9.1			
100				1000				10				100	35.7	11		1000				10.0			
110			A	1100				11				110				1100				11.0			
120				1200				12				120				1200				12.0	81.0		
130				1300				13				130				1300				13.0			
150				1500				15	29.4	8	B	150				1500				15.0			
160				1600				16				160				1600				16.0			
180				1800				18				180				1800	56.5	15		18.0			
200	12.5	2		2000	19.8	5		20				200	38.1	12		2000				20.0			
220				2200				22				220				2200							
240				2400				24				240				2400							
270				2700				27	30.8	9		270				2700							

*The resistance values shown are from the standard 24-value series decade shown in MIL-T-23648 Other values, as well as values specified at other reference temperatures, are available on request.

See Curves Pages L-1 and L-2

Probes & Rods - Series P60, P65, P85, and P100

TABLE 1 - STANDARD TOLERANCES

Tolerance Code Letter	F	G	J	K	L	M	N	P	Q	R	S
±% Tolerance @ 25°C	1	2	5	10	15	20	25	30	40	50	Non-Standard (Specify value)

THERMAL AND ELECTRICAL PROPERTIES

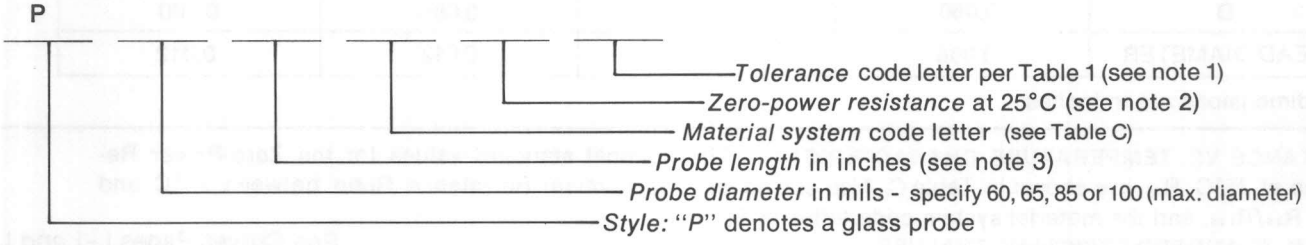
(Definitions and test methods per MIL-T-23648)

		Series P60	Series P65	Series P85	Series P100
Thermal Time Constant	in still air	12 sec.	13 sec.	16 sec.	22 sec.
	water plunge	300 mSec.	320 mSec.	400 mSec.	650 mSec.
Dissipation Constant	in still air	.6 mW/°C	.65 mW/°C	.8 mW/°C	1.0 mW/°C
	in still water	3.0 mW/°C	3.3 mW/°C	4.0 mW/°C	5.0 mW/°C
Resistance Range		30-20M ohms	30-20M ohms	30-20M ohms	30-20M ohms
Maximum Power Rating		.060 watts	.065 watts	.075 watts	.100 watts

Maximum Temperature - All THERMOPROBES are aged at 300°C for extended periods of time. As such, they exhibit excellent stability for all temperatures at or below 300°C. Intermittent operation at temperatures up to 600° is permissible. When additional pre-conditioning is specified, compliance with the performance requirements of MIL-T-23648 can be guaranteed.

ORDERING INFORMATION

The Code Number to be ordered may be specified as follows:



Notes: 1) Special tolerances are available on request. To specify a non-standard tolerance, use the letter "S" followed by the desired tolerance (i.e., SO.5 = ±0.5%).

2) The zero-power resistance at 25°C, expressed in ohms, is identified by a three digit number. The first two digits represent significant figures, and the last digit specifies the number of zeros to follow.

3) The nominal probe length available for each series is indicated in the chart below:

NOMINAL PROBE LENGTH	1/8	(1/4)	3/8	(1/2)	3/4	1	1 1/4	1 1/2	1 3/4	2
ORDERING CODE LETTER	A	B	C	D	F	H	K	M	P	R
Series P100	—	—	—	—	—	—	—	—	—	—
Series P85	—	—	—	—	—	—				
Series P65	—	—	—	—						
Series P60	—	—	—	—						

○ CIRCLED LENGTHS ARE NORMALLY STOCKED

For example, an 0.060 inch max. diameter x 1/4 inch long glass probe with a zero-power resistance at 25°C of 2000Ω and a tolerance of ±20% would be specified as P 60 BA 202 M.

OPTIONS The standard units may be modified to suit the users particular needs by specifying any of the following options:

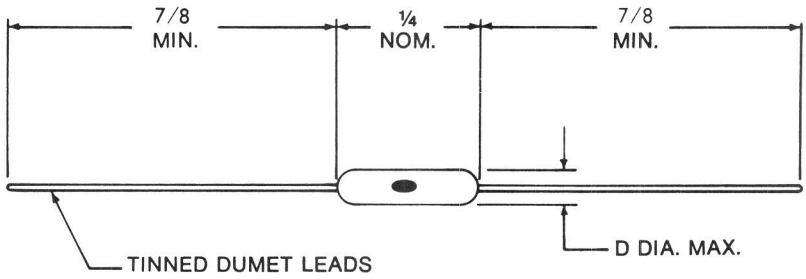
- Non-standard resistance values.
- Non-standard sizes.
- Reference temperature(s) other than 25°C.
- Non-standard tolerances (at 1 or more temperatures).
- Special alloy leads for continuous lead exposure to high temperatures (in excess of 300°C).
- Longer or shorter leads.
- Special mountings and enclosures.
- Calibration - specify temperatures.
- Interchangeable pairs, sets; curve matching - specify temperature(s) and tolerance(s).
- Special aging for high reliability applications.
- Extension leads - specify lead material, diameter, length, and insulation, if any. Also specify if moisture proof seal is desired over joint.

PROBES & RODS

SERIES R60, R65, R85, and R100
Ruggedized

All ruggedized THERMORODS are designed to meet or exceed the performance requirements of MIL-T-23648.

STYLE: The ruggedized THERMOROD consists of a bead thermistor hermetically sealed in the center of a shock resistant glass rod. Axial leads are provided to permit mounting in a manner similar to that used for resistors or diodes. These units are mechanically rugged and unaffected by severe environmental exposures, including high density nuclear radiation. They exhibit excellent long term stability.



DIMENSION	SERIES R60	SERIES R65	SERIES R85	SERIES R100
D	0.060	0.065	0.085	0.100
LEAD DIAMETER	0.008	0.008	0.012	0.012

All dimensions are in inches.

RESISTANCE VS. TEMPERATURE CHARACTERISTIC - The nominal standard values for the Zero-Power Resistance at 25°C, R_{25}, are shown in Table C. Also shown are the nominal Resistance Ratio between 25°C and 125°C, R_{25}/R_{125}, and the material system code letter (MS).

TABLE C - STANDARD RESISTANCE VALUES

See Curves Pages L-1 and L-2

R_{25} Ω	$\frac{R_{25}}{R_{125}}$	R-T Curve	MS	R_{25} Ω	$\frac{R_{25}}{R_{125}}$	R-T Curve	MS	R_{25} KΩ	$\frac{R_{25}}{R_{125}}$	R-T Curve	MS	R_{25} KΩ	$\frac{R_{25}}{R_{125}}$	R-T Curve	MS	R_{25} KΩ	$\frac{R_{25}}{R_{125}}$	R-T Curve	MS	R_{25} MΩ	$\frac{R_{25}}{R_{125}}$	R-T Curve	MS
30	5.0		E	300	12.5	2	A	3.0	19.8	5	A	30	30.8	9	B	300	38.1	12	B	3.0	75.6	16	D
33				330				3.3				33				330				3.3			
36				360	14.0	3		3.6	22.1	6		36				360	45.0	13		3.6			
39				390				3.9				39				390				3.9			
43				430				4.3				43	32.3	10		430				4.3			
47				470				4.7				47				470				4.7			
51				510				5.1				51				510				5.1			
56				560				5.6				56				560				5.6			
62				620				6.2	22.7	7		62				620				6.2			
68				680				6.8				68				680				6.8			
75				750	16.9	4		7.5				75				750	48.1	14		7.5			
82	11.8	1		820				8.2				82				820				8.2			
91				910				9.1				91				910				9.1			
100				1000				10				100	35.7	11		1000				10.0			
110				1100				11				110				1100				11.0			
120				1200				12				120				1200				12.0			
130				1300				13				130				1300				13.0			
150				1500	19.8	5		15	29.4	8	B	150				1500	56.5	15		15.0	81.0		
160				1600				16				160				1600				16.0			
180				1800				18				180	38.1	12		1800				18.0			
200	12.5	2		2000				20				200				2000				20.0			
220				2200				22				220				2200							
240				2400				24				240				2400							
270				2700				27	30.8	9		270				2700							

*The resistance values shown are from the standard 24-value series decade shown in MIL-T-23648. Other values, as well as values specified at other reference temperatures, are available on request.

TABLE 1 - STANDARD TOLERANCES

Tolerance Code Letter	F	G	J	K	L	M	N	P	Q	R	S
±% Tolerance @ 25°C	1	2	5	10	15	20	25	30	40	50	Non-Standard (Specify value)

THERMAL AND ELECTRICAL PROPERTIES

(Definitions and test methods per MIL-T-23648)

		Series R60	Series R65	Series R85	Series R100
Thermal Time Constant	in still air	12 sec.	13 sec.	16 sec.	22 sec.
	water plunge	300 mSec.	320 mSec.	400 mSec.	650 mSec.
Dissipation Constant	in still air	.6 mW/°C	.65 mW/°C	.8 mW/°C	1.0 mW/°C
	in still water	3.0 mW/°C	3.3 mW/°C	4.0 mW/°C	5.0 mW/°C
Resistance Range		30-20M ohms	30-20M ohms	30-20M ohms	30-20M ohms
Maximum Power Rating		.060 watts	.065 watts	.075 watts	.100 watts

Maximum Temperature - All ruggedized THERMORODS are aged at 300°C for extended periods of time. As such, they exhibit excellent stability for all temperatures at or below 300°C. Intermittent operation at temperatures up to 600°C is permissible. When additional pre-conditioning is specified, compliance with the performance requirements of MIL-T-23648 can be guaranteed.

ORDERING INFORMATION

The Code Number to be ordered may be specified as follows:

R _____ _____ _____ _____ _____

- _____ *Tolerance* code letter per Table 1 (see note 1)
- _____ *Zero-power resistance* at 25°C (see note 2)
- _____ *Material system* code letter (see Table C)
- _____ *Diameter* of glass rod in mils - specify 60, 65, 85 or 100 (max. diameter)
- _____ *Style: "R"* denotes a ruggedized bead structure.

Notes: 1) Special tolerances are available on request. To specify a non-standard tolerance, use the letter "S" followed by the desired tolerance (i.e., S3 = ±3%).

2) The zero-power resistance at 25°C, expressed in ohms, is identified by a three digit number. The first two digits represent significant figures and the last digit specifies the number of zeros to follow.

For example, a 0.100 inch max. diameter ruggedized THERMOROD with a zero-power resistance at 25°C of 2000Ω and a tolerance of ±20% would be specified as R 100 A 202 M.

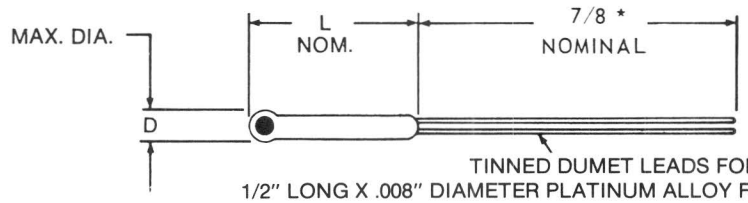
OPTIONS: The standard units may be modified to suit the users particular needs by specifying any of the following options:

- Non-standard resistance values.
- Non-standard sizes.
- Reference temperature(s) other than 25°C.
- Non-standard tolerances (at 1 or more temperatures).
- Special alloy leads for continuous lead exposure to high temperatures (in excess of 300°C).
- Longer or shorter leads.
- Special mountings and enclosures.
- Calibration - specify temperatures.
- Interchangeable pairs, sets; curve matching - specify temperature(s) and tolerance(s).
- Special aging for high reliability applications.
- Extension leads - specify lead material, diameter, length, and insulation, if any. Also specify if moisture proof seal is desired over joint.

ULTRASTABLE SERIES SP60, SP65, SP85, and SP100

All ULTRA-STABLE THERMOPROBES are designed to meet or exceed the performance requirements of MIL-T-23648.

STYLE: The ULTRA-STABLE THERMOPROBE consists of a bead thermistor hermetically sealed in the tip of a shock resistant glass rod. These units have been processed for maximum long term stability and reliability. They are rugged and unaffected by severe environmental exposures, including high density nuclear radiation.



*Longer leads available on request.

STANDARD SIZES OF SERIES SP60, SP65, SP85 AND SP100 THERMOPROBES

DIMENSION	SERIES SP60		SERIES SP65		SERIES SP85		SERIES SP100	
D	0.060		0.065		0.085		0.100	
L	¼	½	¼	½	¼	½	¼	½
LEAD DIAMETER	0.008		0.008		0.012		0.012	

All dimensions are in inches.

RESISTANCE VS. TEMPERATURE CHARACTERISTIC The nominal standard values for the Zero-Power Resistance at 25°C, R_{25}, are shown in Table C on page C-5

TABLE 1 - STANDARD TOLERANCES

Tolerance Code Letter	F	G	J	K	L	M	N	P	Q	R	S
±% Tolerance @ 25°C	1	2	5	10	15	20	25	30	40	50	Non-Standard (Specify value)

THERMAL AND ELECTRICAL PROPERTIES

(Definitions and test methods per MIL-T-23648)

		Series SP60	Series SP65	Series SP85	Series SP100
Thermal Time Constant	in still air	12 sec.	13 sec.	16 sec.	22 sec.
	water plunge	300 mSec.	320 mSec.	400 mSec.	650 mSec.
Dissipation Constant	in still air	.6 mW/°C	.65 mW/°C	.8 mW/°C	1.0 mW/°C
	in still water	3.0 mW/°C	3.3 mW/°C	4.0 mW/°C	5.0 mW/°C
Resistance Range		30-20M ohms	30-20M ohms	30-20M ohms	30-20M ohms

MAXIMUM TEMPERATURE - All THERMOPROBES are aged at 300°C for extended periods of time. As such, they exhibit excellent stability for all temperatures at or below 300°C. Special additional aging is often used to stabilize units for particular temperature applications. Units purchased for stability class A should not be used in the higher temperature stability classes B & C (see stability).

Probes & Rods - Series SP60, SP65, SP85, and SP100

STABILITY: The ULTRA-STABLE SERIES THERMISTOR PROBES are available in three temperature classes and six stability groups. Table 2 lists the possible combinations for each resistance range.

TABLE 2 - STABILITY CLASS

	STABILITY GROUP PERCENT RESISTANCE PER YEAR					1 = .02% 2 = .05% 3 = .075%						4 = .1% 5 = .2% 6 = .5%					
RESISTANCE RANGE	**TEMP. CLASS "A" = 105° C MAX.**					**TEMP. CLASS "B" = 200° C**						**TEMP. CLASS "C" = 300° C**					
100 Ω - 1KΩ	—	—	A3	A4	A5	—	—	—	—	—	B6	—	—	—	—	—	C6
1K Ω - 3KΩ	A1	A2	A3	A4	A5	—	—	—	—	B5	B6	—	—	—	—	—	C6
3KΩ - 10KΩ	A1	A2	A3	A4	A5	—	—	—	—	B5	B6	—	—	—	—	—	C6
10KΩ - 50KΩ	—	A2	A3	A4	A5	—	—	—	—	B5	B6	—	—	—	—	—	C6
50KΩ - 100KΩ	—	A2	A3	A4	A5	—	—	—	—	B5	B6	—	—	—	—	—	C6
100KΩ - 1MΩ	—	A2	A3	A4	A5	—	—	—	—	B5	B6	—	—	—	—	—	C6
1MΩ - 20MΩ	—	—	—	A4	A5	—	—	—	—	—	B6	—	—	—	—	—	C6

ORDERING INFORMATION

The Code Number to be ordered may be specified as follows:

SP ____ ____ ____ ____ ____ ____ ____

- *Stability Class* (see Table 2)
- *Tolerance* code letter per Table 1 (see note 1)
- *Zero-power resistance* at 25°C (see note 2)
- *Material system* code letter (see Table C, Page C-3).
- *Probe length* in inches (see note 3)
- *Probe diameter* in mils - specify *60, 65, 85 or 100* (max. diameter)
- *Style: "SP"* denotes an ultra stable glass probe

Notes: 1) Special tolerances are available on request. To specify a non-standard tolerance, use the letter "S" followed by the desired tolerance (i.e., SO.5 = ±0.5%).

2) The zero-power resistance at 25°C, expressed in ohms, is identified by a three digit number. The first two digits represent significant figures, and the last digit specifies the number of zeros to follow.

3) The nominal probe length, in inches, is specified by a letter, as follows:

NOMINAL PROBE LENGTH	⅛	¼	½
ORDERING CODE LETTER	A	B	D

For example, an 0.060 inch maximum diameter x ¼ inch long glass probe with a zero-power resistance at 25° C of 2000 Ω, a tolerance of ±20%, a desired stability of ±.05% per year and a maximum temperature rating of 105° C would be specified as SP 60 BA 202 M A 2

OPTIONS The standard units may be modified to suit the users particular needs by specifying any of the following options.

- Non-standard resistance values.
- Non-standard sizes.
- Reference temperature(s) other than 25°C.
- Non-standard tolerances (at 1 or more temperatures).
- Solderable and weldable leads.
- Longer or shorter leads.
- Extension leads - specify lead material, diameter, length, and insulation, if any. Also specify if moisture proof seal is desired over joint.
- Special mountings and enclosures.
- Calibration - specify temperatures.
- Interchangeable pairs, sets; curve matching — specify temperature(s) and tolerance(s).

CALIBRATION Calibration service is available for these units with temperature accuracy to 0.0015°C and resistance accuracy to 0.005%. Either specific temperature points or a selected temperature range may be chosen for calibration. For range calibration, a computer readout can be furnished at increments of .001°C to 1°C.

APPLICATIONS: The SP SERIES THERMOPROBES are used where maximum stability and reliability are required. They may be calibrated and used as secondary temperature standards. They may be used as thermal sensors, in the same manner as standard THERMOPROBES with the added assurance of known long term stability.

THERMOFLAKES
High Temperature, Low Noise & Infrared

STYLE
THERMOFLAKES consist of thick film thermistors which have no substrate backings. Since their lead wires are fired directly into their electrodes, solder leaching and diffusion are completely eliminated. This results in excellent, low noise ohmic contacts.

APPLICATIONS
The high surface-to-mass ratio associated with a THERMOFLAKE results in low heat capacity and fast response time. THERMOFLAKES are ideally suited for infrared detection. Since the thermistor materials used are good absorbers of IR energy, satisfactory results may be obtained without the use of special absorption coatings. Such coatings do, however, provide more uniform absorption over a specified spectral wave length band. THERMOFLAKES may also be used for high speed temperature measurement, control, and compensation.

STANDARD THICKNESSES
THERMOFLAKES are available in standard thicknesses of 25 microns (0.001") and 50 microns (0.002"). Thinner units for faster response and thicker units for lower cost and greater ruggedness are available upon request.

SIZES — EFFECTIVE AREA
THERMOFLAKES may be purchased in the following standard sizes:

0.5x0.5mm (.020x.020")	2x2 mm (.080x.080")
0.5x1.0mm (.020x.040")	2x3 mm (.080x.120")
1x1 mm (.040x.040")	3x3 mm (.120x.120")
1x2 mm (.040x.080")	

THERMOFLAKES with larger and smaller cross sections are available on special request. When used for detecting IR energy, the flake is mounted in an inverted position so that its black side faces the incident radition and its electrodes face away from the IR source. This results in greater efficiency since the entire flake area becomes the effective area.

MOUNTINGS

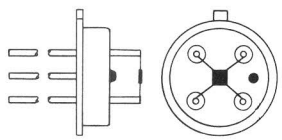


FIGURE D1-1 — A500
Single Thermoflake on T0-5 Header

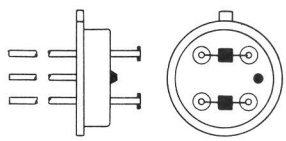


FIGURE D1-2 — A501
Matched Pair of Thermoflakes Side-By-Side Mounting

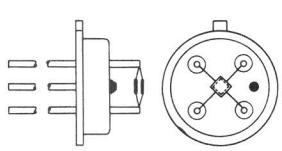


FIGURE D1-3 — A502
Matched Pair of Thermo-flakes Vertical Mounting, One Above Other

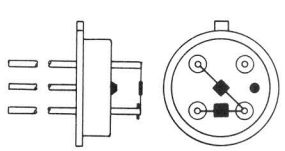


FIGURE D1-4 — A505
Matched Pair of Thermoflakes Side-By-Side Mounts, One in Center

COATINGS
Absorptive coatings, such as 3M Black Velvet, are available on request. The absorptivity of the uncoated THERMOFLAKE is reasonably flat at approximately 40-45% in the range of 5-15 microns. Although an absorptive coating will result in a somewhat flatter spectral response at almost twice the absorptivity, it will not necessarily improve the sensitivity. This is due to the fact that the increased absorptivity is obtained at the expense of increased thermal mass.

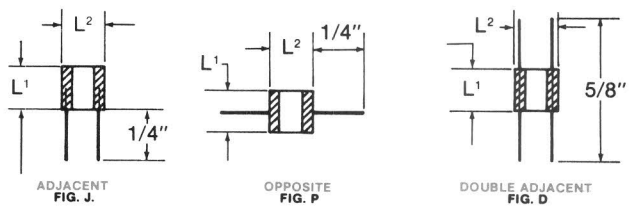
FILTERS
Coated germanium filters which exhibit a passband of 7.5-13 microns are available from stock. Other windows are available on request.

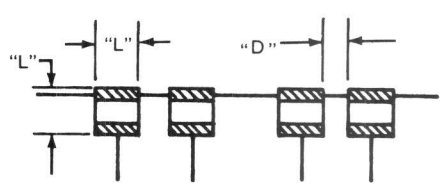
MAXIMUM AMBIENT TEMPERATURE
THERMOFLAKES may be operated at temperatures as high as 300°C although maximum stability is obtained at temperatures below 105°C.

THERMAL AND ELECTRICAL PROPERTIES
* DISSIPATION CONSTANT:
  0.2-0.4 Milliwatt/°C
* THERMAL TIME CONSTANT:
  35-75 Milliseconds
* Values specified are for the THERMOFLAKE mounted by its leads in still air at 25°C. The actual value, within the range provided, depends upon the cross section and thickness of the flake. Time constant values represent cooling response to an electrical pulse which does not heat the leads significantly.
* RESISTANCE RANGE:
  50 K ohms to 2 Megohms, see Table D2-B for standard values. Values between 1 K ohm and 100 Megohms are available on special order.

TEMPERATURE COEFFICIENT
Varies between -3.9%/°C and -4.4%/°C depending on size, thickness and the resistance of the THERMOFLAKE.

LEAD CONFIGURATIONS





(FIGURE D1-5) A504X-THERMOFLAKE ARRAY — SPECIFY NUMBER OF ELEMENTS

THERMOFLAKES

Table D2-A THERMOFLAKE SIZES

Ordering Code		F20	FB20	F40	FB40	F80	FA80	F120
L_1	inches	.020	.020	.040	.040	.080	.080	.120
	(mm)	(.5)	(.5)	(1)	(1)	(2)	(2)	(3)
L_2	inches	.020	.040	.040	.080	.080	.120	.120
	(mm)	(.5)	(.5)	(1)	(2)	(2)	(3)	(3)

Table D2-B STANDARD RESISTANCE VALUES

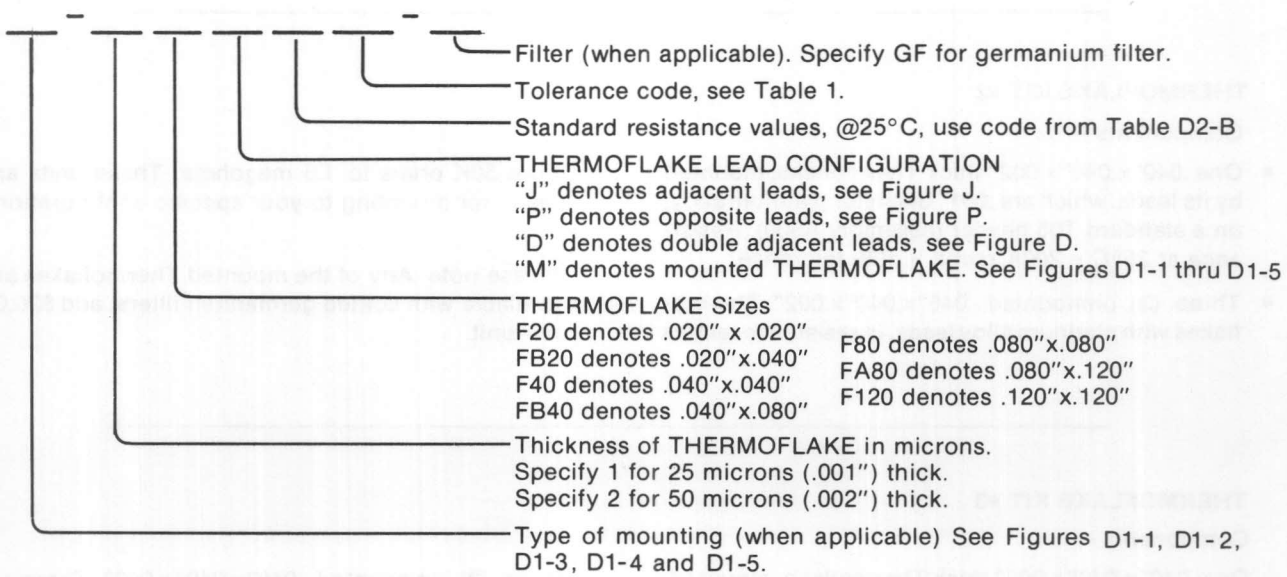
R_o @ 25°C (in ohms)	50K	100K	200K	500K	1 Meg	1.5 Meg	2 Meg
Ordering Code	503	104	204	504	105	155	205

Non-Standard Resistance Values are available on request. The resistance is identified by the three digit code per MIL-T-23648A.

TABLE 1 STANDARD TOLERANCES

Tolerance Code Letter	F	G	J	K	L	M	N	P	Q	R	S
± % Tolerance @ 25° C	1	2	5	10	15	20	25	30	40	50	Non-Standard (Specify value)

ORDERING INFORMATION The ordering code should be specified as follows:



Ordering Examples:

1. A 50 micron thick THERMOFLAKE with a cross section of 1mm x 1mm, mounted on a T0-5 header (mounting A-500, figure D1-1) and having a resistance of 1 meghom ±25% at 25°C would be specified as: A500-2F40M105N. If a coated germanium filter were required, the part number would be: A500-2F40M105N-GF.
2. An unmounted THERMOFLAKE having a thickness of 25 microns, a cross section of 2mm x 2mm, double adjacent leads and a resistance of 500K ohms ± 20% at 25°C would be specified as 1F80D504M.

OPTIONS

Non-standard Resistance Values
Custom Assemblies
Calibration, specify temperature(s)
Matched pairs
Other Sizes
Other style headers

THERMOFLAKES

KITS

APPLICATIONS:

All of the Thermoflakes in our Kits are suitable for use in non-contact temperature measurement, flow measurement, gas chromatography, and general temperature measurement and control.

THERMOFLAKE KIT #1

Components —

- One .040"x.040"x.002" thick Thermoflake, mounted by its leads, which are .0007" diameter platinum alloy, on a standard T05 header (Assembly A500). *Resistance at 25°C = 1 megohm,* ±40% tolerance.
- Three (3) unmounted .040"x.040"x.002" Thermoflakes with platinum alloy leads, in resistance ranges from 50 K ohms to 1.5 megohms. These units are ready for mounting to your specific configuration.

Please note: Any of the mounted Thermoflakes are available with coated germanium filters, add $20.00 per unit.

THERMOFLAKE KIT #2

Components —

- One .040"x.040"x.002" thick Thermoflake, mounted by its leads, which are .001" diameter platinum alloy, on a standard T05 header (assembly A500). *Resistance at 25°C = 200K ohms,* ±40% tolerance.
- Three (3) unmounted .040"x.040"x.002" Thermoflakes with platinum alloy leads, in resistance ranges from 50K ohms to 1.5 megohms. These units are ready for mounting to your specific configuration.

Please note: Any of the mounted Thermoflakes are available with coated germanium filters, add $20.00 per unit.

THERMOFLAKE KIT #3

Components —

- One .040"x.040"x.002" thick Thermoflake, mounted on its leads, which are .0007" diameter platinum alloy, on a standard T05 header (Assembly A500). *Resistance at 25°C = 1 megohm,* ±40% tolerance.
- One .040"x.040"x.002" thick Thermoflake mounted by its leads, which are .001" diameter platinum alloy, on a standard T05 header (assembly A500). *Resistance at 25°C = 200K ohms,* ±40% tolerance.
- Three (3) unmounted .040"x.040"x.002" Thermoflakes with platinum alloy leads, in resistance ranges from 500K ohms to 1.5 megohms. These units are ready for mounting to your specific configuration.

Please note: Any of the mounted Thermoflakes are available with coated germanium filters, add $20.00 per unit.

Thermoflakes — Kits

THERMOFLAKE KIT #4

Components —

- Two .040"x.040"x.002" thick Thermoflakes, mounted by .001" platinum alloy leads, *side by side,* on a standard T05 header (Assembly A505, p. D-1). The flakes have a resistance at 25°C of 200K ohms and are ratio matched to 0.5% ($R_{0°C}/R_{50°C}$) and resistance matched to 10% at $R_{25°C}$. This matched set provides temperature compensation for the "sensor" thermistor over the operating range.
- Three (3) unmounted .040"x.040"x.002" Thermoflakes with platinum alloy leads, in resistance ranges from 50K ohms to 1.5 megohms. These units are ready for mounting to your specific configuration.

Please note: Any of the mounted Thermoflakes are available with coated germanium filters, add $20.00 per unit.

THERMOFLAKE KIT #5

Components —

- Two .040"x.040"x.002" thick Thermoflakes, mounted by .001" platinum alloy leads, *one above the other,* centered, on a standard T05 header (see Assembly A502, p. D-1). The flakes have a resistance at 25°C of 200K ohms and are ratio matched to 0.5% ($R_{0°C}/R_{50°C}$) and resistance matched to 10% at $R_{25°C}$. This configuration provides automatic radiation shielding for the reference (compensating) thermistor and temperature compensation for the "sensor" thermistor over the operating range.
- Three (3) unmounted .040"x.040"x.002" Thermoflakes with platinum alloy leads, in resistance ranges from 50K ohms to 1.5 megohms. These units are ready for mounting to your specific configuration.

Please note: Any of the mounted Thermoflakes are available with coated germanium filters, add $20.00 per unit.

THERMOFLAKE KIT #6 (Matched)

Components —

- Two .040"x.040"x.002" thick Thermoflakes, mounted by .001" platinum alloy leads, *side by side,* on a standard T05 header (Assembly A505 see p. D-1). The flakes have a resistance at 25°C of 200K ohms and are ratio matched to 0.5% ($R_{0°C}/R_{50°C}$) and resistance matched to 10% at $R_{25°C}$.
- Two flakes, as above, *mounted one above the other* and centered, on a standard T05 header (Assembly A502, see p. D-1). These matched sets provide temperature compensation for the "sensor" thermistor over the operating range.
- Three (3) unmounted .040"x.040"x.002" Thermoflakes with platinum alloy leads, in resistance ranges from 50K ohms to 1.5 megohms. These units are ready for mounting to your specific configuration.

Please note: Any of the mounted Thermoflakes are available with coated germanium filters, add $20.00 per unit.

THERMOFLAKES

MICROCIRCUIT

STYLE

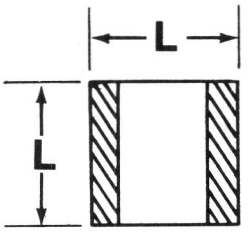
MICROCIRCUIT THERMOFLAKES are thick film thermistor flakes which have no substrate backing. They are supplied with two solderable electrodes on one surface, making them ideally suited for surface (substrate) or pin mounting. Through the use of newly developed fabrication techniques at Thermometrics, it has been possible to obtain high temperature, low noise devices which provide an order of magnitude reduction in noise, when compared with other commercially available flake thermistors.

MICROCIRCUIT THERMOFLAKES are available in standard thickness of 0.003"-0.005" for ease of handling in high production applications.

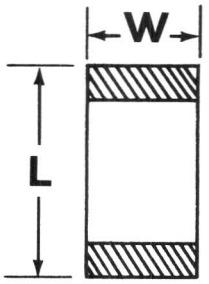
CONFIGURATION

MICROCIRCUIT THERMOFLAKES are made in standard square and rectangular forms as shown below.

SPECIAL ORDER ONLY



SQUARE
FIG. (1)



RECTANGULAR
FIG. (2)

Standard Sizes, Resistance Values and Ratio ($R_{25°C}/R_{125°C}$) for Microcircuit Thermoflakes.

Figure	Style Code	Configuration	Size (in inches)	STANDARD RESISTANCE VALUES @ 25°C ± 40% AND ASSOCIATED RATIO $R_{25°C}/R_{125°C}$
1		**Square**	**Dimension ("L" x "L")**	
	FM20	Square	0.020" x 0.020"	
	FM40	Square	0.040" x 0.040"	
	FM80	Square	0.080" x 0.080"	
	FM120	Square	0.120" x 0.120"	
2		**Rectangular**	**Dimension ("W" x "L")**	
	FMB20	Rectangular	0.020" x 0.040"	
	FMB40	Rectangular	0.040" x 0.080"	
	FMB60	Rectangular	0.060" x 0.120"	

R_T	1K	5K	50K	500K
Ratio	9.0	11.5	19.8	29.7

R_T	2K	10K	100K	1 Meg
Ratio	9.0	11.5	19.8	29.7

THERMOMETRICS 808 U.S. HIGHWAY 1 EDISON, NEW JERSEY 08817 TEL. 201-287-2870

Thermoflakes — Microcircuit

MAXIMUM TEMPERATURE

All MICROCIRCUIT THERMOFLAKES are designed for continuous operation at temperatures up to 125°C. When additional pre-conditioning is specified units may be operated up to 300°C.

TEMPERATURE COEFFICIENTS & RESISTANCE-TEMPERATURE DATA

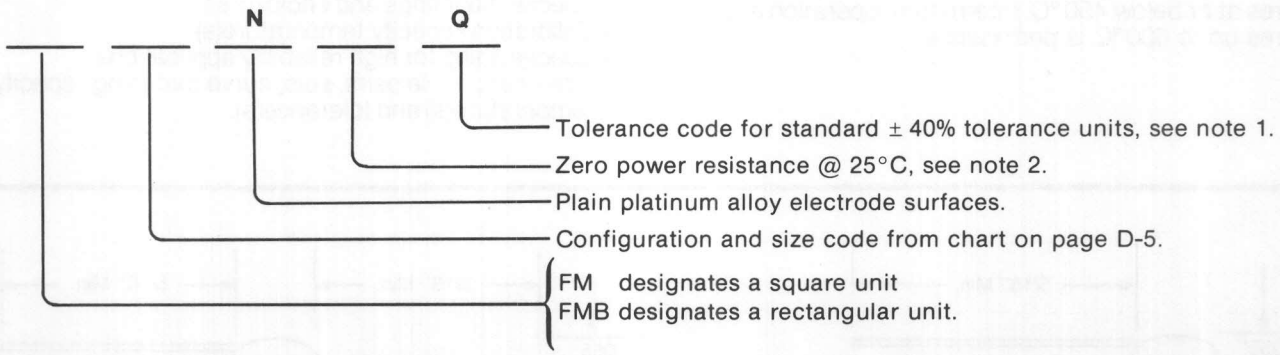
Varies between -3.3%/°C and -4.0%/°C, @ 25°C, depending on size, thickness and the resistance of the Thermoflake. Coefficients may be determined by referring to the chart on page D-5 for ratio values and then selecting the "Resistance-Temperature Characteristics Curve" on the inside back cover. Resistance-Temperature data is given on this same curve.

THERMAL AND ELECTRICAL PROPERTIES

(Definitions and test methods per MIL-T-23648)

	Microcircuit Flakes
Thermal Time Constant in still air	0.125 sec.
Dissiptation Constant in still air	0.50 mW/°C
Resistance Range	1K to 1M ohms
Maximum Power Rating	0.050 watts

Ordering Information — the part number may be specified as follows:



NOTES:

1. Special tolerances are available on request. To specify a non-standard tolerance, use the letter "S" followed by the desired tolerance (ie, S25 = ± 25%).
2. The zero-power resistance @25°C, expressed in ohms, is identified by a three digit number. The first two digits represent significant figures, the last digit is the number of zeroes to follow. Therefore a 0.040" x 0.040" unit of 10K ohms and standard tolerance would be specified as FM40N103Q.

OPTIONS:

Non-standard resistance values
Non-standard tolerances
Matched pairs — specify temperature(s) and tolerance(s)
Non-standard sizes
References temperatures other than 25°C
Calibration — specify temperature

HIGH TEMP (ON SPECIAL ORDER)

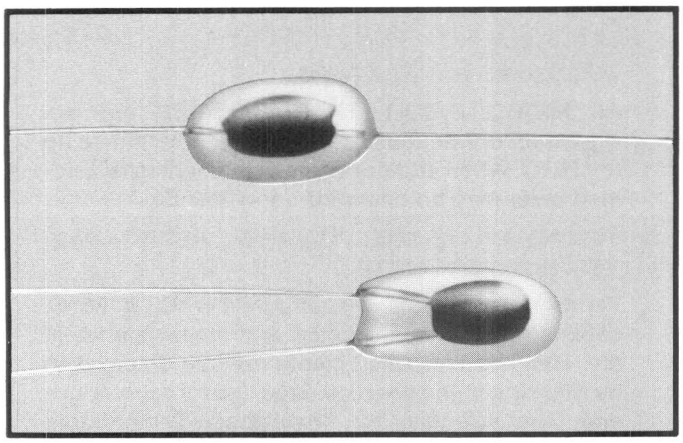
SERIES HTBR55

All THERMOBEADS are designed to meet or exceed the performance requirements of MIL-T-23648. The ruggedized HI-TEMP THERMOBEADS are recommended for use in severe environments and in high reliability applications.

STYLE: The ruggedized HI-TEMP THERMOBEADS consist of a bead thermistor hermetically sealed in a special shock resistant glass. The series HTBR55 THERMOBEAD has a nominal diameter of 0.055 inch. Unlike commercial bead thermistors, the HI-TEMP THERMOBEADS exhibit excellent long term stability at continuous operating temperatures up to 450 °C. They are also unaffected by severe nuclear radiation.

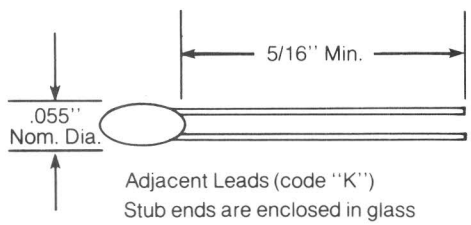
APPLICATIONS: The series HTBR55 THERMOBEADS are ideally suited for assembly operations in which the thermistor lead wires may be inadvertently tugged. With conventional glass coated bead thermistors the glass seal may be ruptured and, in some cases, the strain can be transmitted to the lead wire-ceramic interface. The ruggedized HTBR55 THERMOBEADS were developed to eliminate such problems and to remain unaffected by severe operating temperatures up to 450 °C.

MAXIMUM TEMPERATURE: The series HTBR55 THERMOBEADS are aged at 450 °C for extended periods of time. As such, they exhibit excellent stability for all temperatures at or below 450 °C. Intermittent operation at temperatures up to 600 °C is permissible.

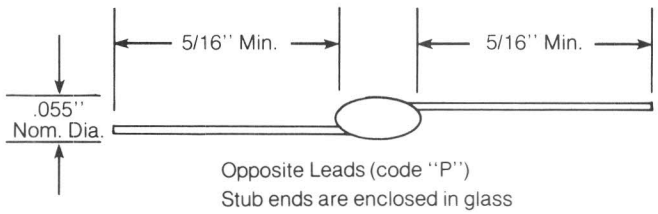


OPTIONS: The standard units may be modified to suit the users particular needs by specifying any of the following options.

- Non-standard resistance values.
- Reference temperature(s) other than 125 °C.
- Non-standard tolerances (at one or more temperatures).
- Longer continuous leads.
- Welded extension leads - specify lead material, diameter, length, and insulation, if any.
- Special mountings and enclosures.
- Calibration - specify temperature(s).
- Special aging for high reliability applications.
- Interchangeable pairs, sets; curve matching - specify temperature(s) and tolerance(s).



Adjacent Leads (code "K")
Stub ends are enclosed in glass



Opposite Leads (code "P")
Stub ends are enclosed in glass

All Dimensions are in inches

Leads are platinum alloy 0.004" dia.

THERMAL AND ELECTRICAL PROPERTIES

(Definitions and test methods per MIL-T-23648)

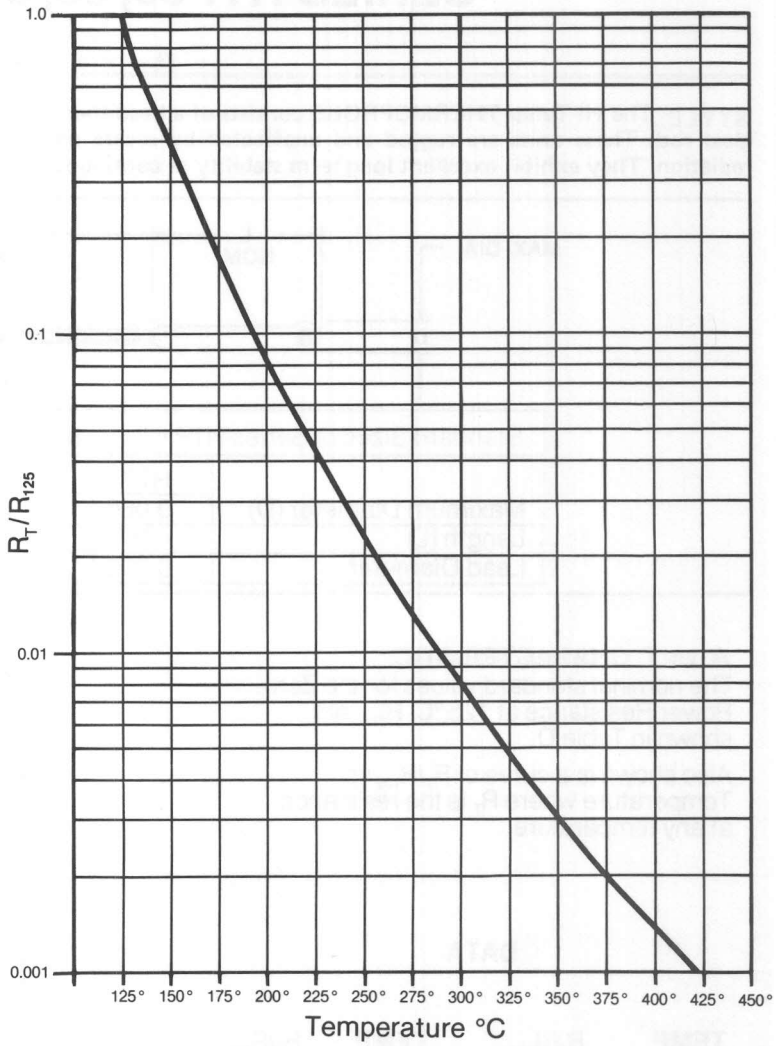
		SERIES HTBR55
DISSIPATION CONSTANT	(Still air @ 25 °C)	0.5 mW/ °C
THERMAL TIME CONSTANT	(Still air @ 25 °C)	7 seconds
RESISTANCE RANGE		110 K to 1 meg. at 125 °C - see Table D for standard values.
MAXIMUM POWER RATING		.050 watts max. - 100% of max. power up to 300 °C then derate linearly to 0% at 450 °C.

High Temp - Series HTBR55

R -vs- T CHARACTERISTIC:

The nominal standard values for the Zero-Power Resistance at 125 °C, R_{125}, are shown in Table D.

Also shown is a curve of R_T/R_{125} vs. Temperature where R_T is the resistance at any temperature.



DATA

TEMP °C	R_T/R_{125}	TEMP °C	R_T/R_{125}
125	1.00000	300	.00793
150	.41087	325	.00487
175	.18272	350	.00310
200	.08720	375	.00203
225	.04430	400	.00138
250	.02380	425	.00096
275	.01344	450	.00068

TABLE D - STANDARD RESISTANCE VALUES

R_T @ 125°C	Resistance Code
510K ohms	514
750K ohms	754
1.0 Megohm	105
1.5 Megohm	155

TABLE 1 - STANDARD TOLERANCES

Tolerance Code Letter	F	G	J	K	L	M	N	P	Q	R	S
± % Tolerance @ 125 °C	1	2	5	10	15	20	25	30	40	50	Non-Standard (Specify value)

ORDERING INFORMATION

The Code Number to be ordered may be specified as follows:

HTBR 55 D

- D — Tolerance code letter per Table 1 (see note 1)
- 55 — Zero-power resistance at 125 °C (see note 2)
- HTBR — Material system code letter
- Lead configuration "K" denotes adjacent leads with stub ends glass coated; "P" denotes opposite leads with stub ends glass coated
- Bead diameter in mils (0.055 inch nominal)
- Style: HTBR denotes a high temperature ruggedized glass enclosed bead

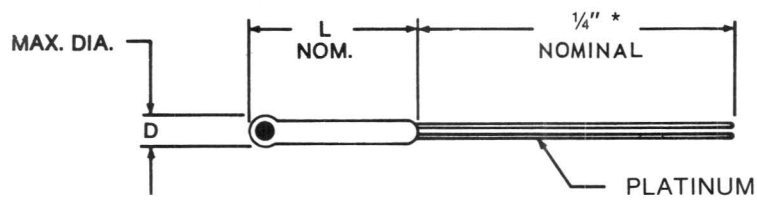
Notes: 1) Special tolerances are available on request. To specify a non-standard tolerance, use the letter "S" followed by the desired tolerance (i.e., S3 = ±3%).

2) The zero-power resistance at 125 °C, expressed in ohms, is identified by a three digit number. The first two digits represent significant figures, and the last digit specifies the number of zeros to follow.

For example, a 0.055 inch nominal diameter glass coated THERMOBEAD with opposite leads, having a zero power resistance at 125 °C of 510 K, and a tolerance of ±20%, would be specified as HTBR55PD 514M.

HIGH TEMP
SERIES HTP60, 65, 85 and 100

STYLE: The Hi-Temp THERMOPROBE consists of a bead thermistor hermetically sealed in the tip of a shock resistant glass rod. These units are rugged and unaffected by severe environmental exposures, including high density nuclear radiation. They exhibit excellent long term stability at continuous operating temperatures up to 450°C.



* Longer Leads Available On Request

Standard Sizes of Series HTP-60, 65, 85 and 100 High Temp Thermoprobes

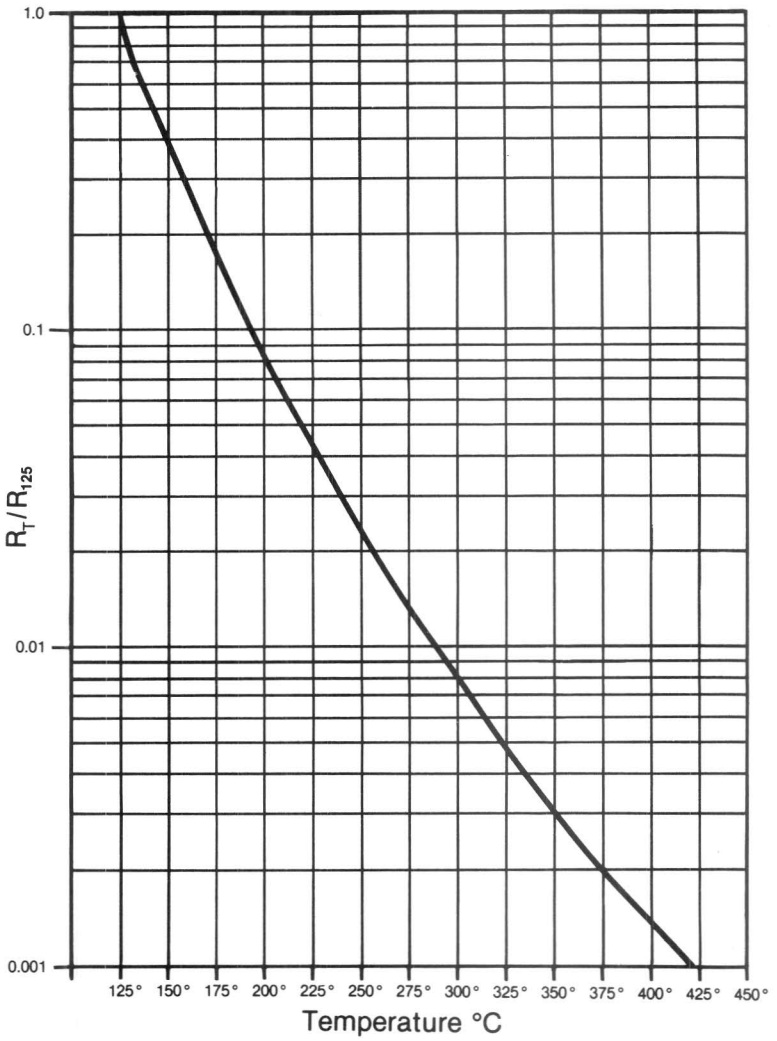
	HTP 60	HTP 65	HTP 85	HTP 100
Maximum Diameter (D)	0.060"	0.065"	0.085"	0.100"
Length (L)	¼"	¼"	¼"	¼"
Lead Diameter	0.008"	0.008"	0.008"	0.008"

½" AVAILABLE

R-vs-T CHARACTERISTIC:

The nominal standard values for the Zero-Power Resistance at 125 °C, R_{125}, are shown in Table D.

Also shown is a curve of R_T/R_{125} vs. Temperature where R_T is the resistance at any temperature.



DATA

TEMP °C	R_T/R_{125}	TEMP °C	R_T/R_{125}
125	1.00000	300	.00793
150	.41087	325	.00487
175	.18272	350	.00310
200	.08720	375	.00203
225	.04430	400	.00138
250	.02380	425	.00096
275	.01344	450	.00068

TABLE D - STANDARD RESISTANCE VALUES

R_T @ 125°C	Resistance Code
510K ohms	514
750K ohms	754
1.0 Megohm	105
1.5 Megohm	155

High Temp - Series HTP60, 65, 85 and 100

TABLE 1 - STANDARD TOLERANCES

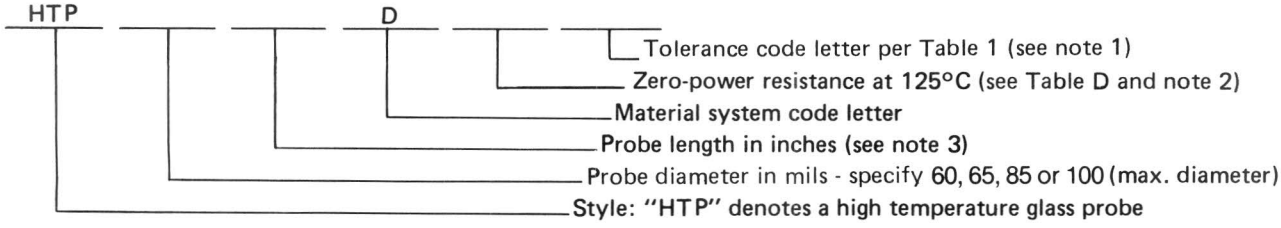
Tolerance Code Letter	F	G	J	K	L	M	N	P	Q	R	S
±% Tolerance @ 125°C	1	2	5	10	15	20	25	30	40	50	Non-Standard (Specify value)

THERMAL AND ELECTRICAL PROPERTIES
(Definitions and test methods per MIL-T-23648)

		Series HTP60	Series HTP65	Series HTP85	Series HTP100
Thermal Time Constant	in still air	12 sec.	13 sec.	16 sec.	22 sec.
Dissipation Constant	in still air	0.60mW/°C	0.65 mW/°C	0.80 mW/°C	1.0 mW/°C
Resistance Range @125°C	(ohms)	100K - 2M	100K - 2M	100K - 2M	100K - 2M
Maximum Power Rating		0.060 watts	0.065 watts	0.075 watts	0.100 watts

MAXIMUM TEMPERATURE - All Hi-Temp THERMOPROBES are aged at 450°C for extended periods of time. As such, they exhibit excellent stability for all temperatures at or below 450°C. Intermittent operation at temperatures up to 600°C is permissible. When additional pre-conditioning is specified, compliance with the performance requirements of MIL-T-23648 can be guaranteed.

ORDERING INFORMATION
The Code Number to be ordered may be specified as follows:



Notes: 1) Special tolerances are available on request. To specify a non-standard tolerance, use the letter "S" followed by the desired tolerance (i.e., SO.5 = ± 0.5%).

2) The zero-power resistance at 125°C, expressed in ohms, is identified by a three digit number. The first two digits represent significant figures, and the last digit specifies the number of zeros to follow.

3) The nominal probe length, in inches, is specified by a letter, as follows:

NOMINAL PROBE LENGTH	¼" STANDARD	½" SPECIAL ORDER
ORDERING CODE LETTER	B	D

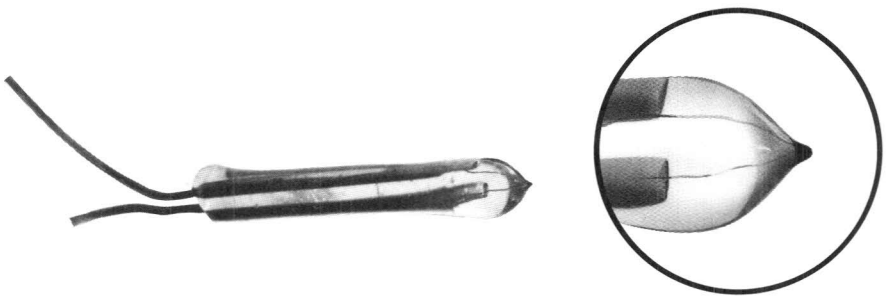
EXAMPLE
For example, 0.06 inch max. diameter x ¼ inch long glass probe with a zero-power resistance at 125°C of 510K and a tolerance of ± 20% would be specified as HT P60BD514M.

OPTIONS: The standard units may be modified to suit the users particular needs by specifying any of the following options.

- Non-standard resistance values.
- Non-standard sizes.
- Reference temperature(s) other than 125°C.
- Non-standard tolerances (at 1 or more temperatures).
- Longer or shorter leads.
- Extension leads - specify lead material, diameter, length, and insulation, if any. Also specify if moisture proof seal is desired over joint.
- Special mountings and enclosures.
- Calibration - specify temperatures.
- Special aging for high reliability applications.

FASTIP THERMOPROBES
SERIES FP07, FP10, and FP14

All THERMOBEADS are designed to meet or exceed the performance requirements of MIL-T-23648.



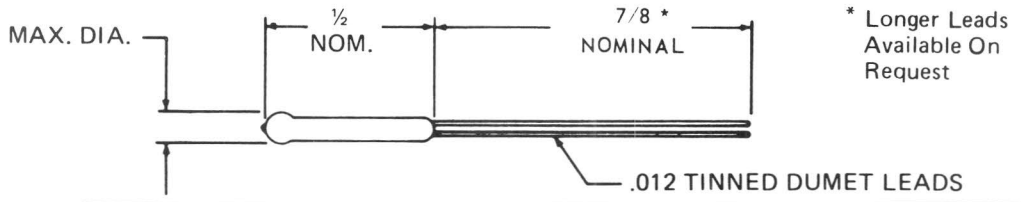
Style

The FASTIP THERMOPROBES consist of small diameter glass coated thermistor beads hermetically sealed at the tips of shock resistant glass rods. The small bead thermistor has a very thin glass coating which allows for relatively flat frequency response for flow applications. As much of the bead as possible is exposed at the tip of the glass rod to provide the fastest response times. The units are rugged and unaffected by severe environmental exposures including high density nuclear radiation.

Applications

The FASTIP THERMOPROBES are ideally suited for high speed measurement and control of fluid temperatures, fluid level or flow. They offer the ease of handling associated with large glass probe thermistors as well as ultra-fast response times of small glass coated bead thermistors. These units exhibit relatively flat response to flow input from 200Hz to 1000Hz.

Maximum Temperature- All THERMOPROBES are aged at 300°C for extended periods of time. As such, they exhibit excellent stability for all temperatures at or below 300°C. Intermittent operation at temperatures up to 600°C is permissible. When additional pre-conditioning is specified, compliance with the performance requirements of MIL-T-23648 can be guaranteed.



Standard Sizes of Series FP07, FP10 and FP14 FASTIP THERMOPROBES

	FP07	FP10	FP14
Maximum Diameter (D)	0.085″	0.085″	0.085″
Length (L)	1/2″	1/2″	1/2″
*Lead Diameter Length	7/8″	7/8″	7/8″

*Longer leads available on request.

THERMAL AND ELECTRICAL PROPERTIES

(Definitions and test methods per MIL-T-23648)

		Series FP07	Series FP10	Series FP14
Thermal Time Constant	in still air	0.10 sec.	0.12 sec.	0.15 sec.
	water plunge	7 mSec.	10 mSec.	16 mSec.
Dissipation Constant	in still air	0.05mW/°C	0.09mW/°C	0.10mW/°C
	in still water	0.25mW/°C	0.45mW/°C	0.50mW/°C
Maximum Power Rating		0.006 watts	0.010 watts	0.014 watts
Resistance Range (ohms)		1K to 10M	1K to 10M	1K to 10M

RESISTANCE VS. TEMPERATURE CHARACTERISTIC - The nominal standard values for the Zero-Power Resistance at 25°C, R_{25}, are shown in Table B. Also Shown are the nominal Resistance Ratio between 25°C and 125°C, R_{25}/R_{125}, and the material system code letter (MS).

Fastip Thermoprobes — Series FP07, FP10, and FP14

TABLE B - STANDARD RESISTANCE VALUES*

R_{25} Ω	$\frac{R_{25}}{R_{125}}$	R-T Curve	MS	R_{25} KΩ	$\frac{R_{25}}{R_{125}}$	R-T Curve	MS	R_{25} KΩ	$\frac{R_{25}}{R_{125}}$	R-T Curve	MS	R_{25} KΩ	$\frac{R_{25}}{R_{125}}$	R-T Curve	MS	R_{25} MΩ	$\frac{R_{25}}{R_{125}}$	R-T Curve	MS
300	11.8	1	A	1.0	12.5	2	A	10	19.8	5	A	100	29.4	8	B	1.0	38.1	12	B
330				1.1				11				110				1.1			
360				1.2				12				120				1.2			
390				1.3				13				130	30.8	9		1.3	45.0	13	
430				1.5				15				150				1.5			
470				1.6	14.0	3		16				160				1.6			
510				1.8				18				180				1.8			
560				2.0				20				200				2.0			
620				2.2				22				220				2.2			
680				2.4				24				240	32.3	10		2.4			
750	12.5	2		2.7				27				270				2.7			
820				3.0				30				300				3.0			
910				3.3				33				330				3.3			
				3.6	16.9	4		36				360	35.7	11		3.6	48.1	14	
				3.9				39				390				3.9			
				4.3				43	22.7	7	A	430				4.3			
				4.7				47				470				4.7			
				5.1				51				510				5.1			
				5.6				56				560				5.6			
				6.2				62				620				6.2			
				6.8				68				680				6.8			
				7.5	19.8	5		75				750				7.5	56.5	15	
				8.2				82	29.4	8	B	820	38.1	12		8.2			
				9.1				91				910				9.1			

*The resistance values shown are from the standard 24-value series decade shown in MIL-T-23648. Other values, as well as values specified at other reference temperatures, are available on request.

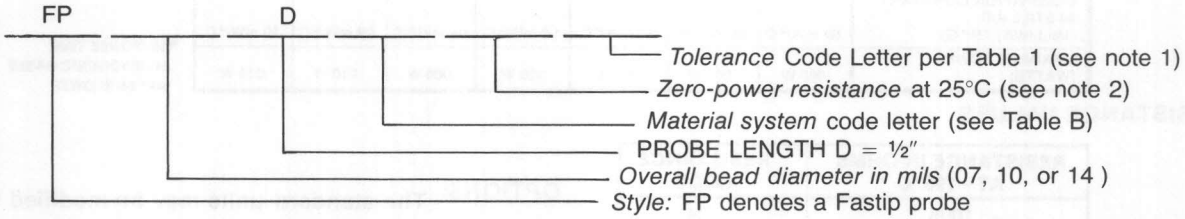
See Curves Pages L-1 and L-2

TABLE 1 - STANDARD TOLERANCES

Tolerance Code Letter	F	G	J	K	L	M	N	P	Q	R	S
±% Tolerance @ 25°C	1	2	5	10	15	20	25	30	40	50	Non-Standard (Specify value)

ORDERING INFORMATION

The Code Number to be ordered may be specified as follows:



Notes: 1) Special tolerances are available on request. To specify a non-standard tolerance, use the letter "S" followed by the desired tolerance (i.e., SO.5=±0.5%).

2) The zero-power resistance at 25°C, expressed in ohms, is identified by a three digit number. The first two digits represent significant figures, and the last digit specifies the number of zeros to follow.

OPTIONS: The standard units may be modified to suit the users particular needs by specifying any of the following options

- Non-standard resistance values.
- Non-standard sizes.
- Reference temperature(s) other than 25°C.
- Non-standard tolerances (at 1 or more temperatures).
- Longer or shorter leads.
- Special alloy leads for continuous lead exposure to high temperatures (in excess of 300°C).
- Special mountings and enclosures.
- Calibration - specify temperatures.
- Interchangeable pairs, sets; curve matching - specify temperature(s) and tolerance(s)
- Special aging for high reliability applications.
- Extension leads - specify lead material, diameter, length, and insulation, if any. Also specify if moisture proof seal is desired over joint.

CRYOGENIC THERMOPROBES

SERIES CTP60, CTP65, CTP85, CTP100

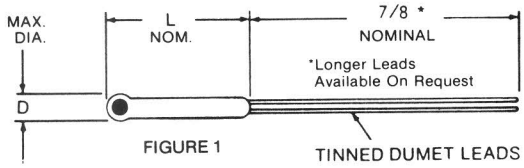


FIGURE 1 TINNED DUMET LEADS

SERIES CTFP07, CTFP10, CTFP14

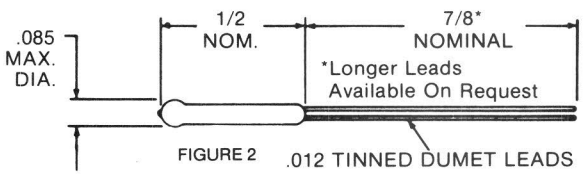


FIGURE 2 .012 TINNED DUMET LEADS

STANDARD SIZES OF SERIES

	CRYOGENIC THERMOPROBES FIG. 1				CRYOGENIC FASTIP FIG. 2		
DIMENSIONS	CTP 60	CTP 65	CTP 85	CTP 100	CTFP 07	CTFP 10	CTFP 14
D (MAX. DIA.)	.060	.065	.085	.100	.085	.085	.085
L (LENGTH)	¼" or ½"	¼" or ½"	¼" or ½"	¼" or ½"	½"	½"	½"
LEAD DIAMETER	.008	.008	.012	.012	.012	.012	.012

STYLE: Cryogenic Thermoprobes consist of bead thermistors hermetically sealed into shock resistant solid glass rods and come in 2 basic styles. The CTFP ... series features a very small glass coated bead extending from the tip of the glass rod while the CTP ... series features a larger bead sealed within the tip of the glass rod. Both styles are rugged easy to handle and unaffected by severe environmental exposures including high density nuclear radiation. The CTFP ... units offer ultrafast response times whereas the CTP ... units are more rugged and at lower cost.

APPLICATIONS: All Cryogenic series Thermoprobes are designed for use in the range of 25°C (room temperature) to -196°C (the boiling point of Liquid Nitrogen). These units are very stable, exhibit no hysteresis effects, and rapid temperature cycling from 25°C to -196°C has no measurable effect on electrical, thermal or mechanical properties. These units are well suited for Cryogenic temperature measurement and control applications such as cryogenic fluid flow, liquid level or temperature sensing in the 25°C to -196°C range. They may be used at temperatures below the Nitrogen Point with suitable instrumentation.

MAXIMUM TEMPERATURE: Cryogenic series Thermoprobes may be exposed to 300°C for short periods. Units can be exposed to 105°C for extended periods, however long term storage at or above 60°C may result in some resistance change, therefore storage below 60°C is recommended for best stability.

THERMAL AND ELECTRICAL PROPERTIES (Definitions and test methods per MIL-T-23648)

THERMAL & ELECTRICAL PROPERTIES	CRYOGENIC THERMOPROBES				CRYOGENIC FASTIP		
	CTP 60	CTP 65	CTP 85	CTP 100	CTFP 07	CTFP 10	CTFP 14
THERMAL TIME CONSTANT IN STILL AIR * (SECONDS)	12 Sec.	13 Sec.	16 Sec.	22 Sec.	.1 Sec.	.12 Sec.	.15 Sec.
DISSIPATION CONSTANT IN STILL AIR (MILLIWATTS/°C)	.60 mW/°C	.65 mW/°C	.80 mW/°C	1.0 mW/°C	.05 mW/°C	.09 mW/°C	.10 mW/°C
MAXIMUM POWER (WATTS)	.060 W	.065 W	.075 W	.100 W	.006 W	.010 W	.014 W

***RESPONSE TIME IN CRYOGENIC GASES MAY BE SLOWER**

STANDARD RESISTANCE VALUES

RESISTANCE IN OHMS AT - 196°C *	RESISTANCE CODE
100K	104
240K	244
510K	514
1 Megohm	105

*Resistance is measured in liquid nitrogen.

RESISTANCE TOLERANCE

Standard tolerance is ± 50% (tolerance code letter R at end of code number). For other tolerances, substitute letter from table 1 (below) for suffix R at end of code number in table above. The CTFP07DE105R is 1 Megohm ± 50% when measured in liquid nitrogen.

OPTIONS: The standard units may be modified to suit the users particular needs by specifying any of the following options:

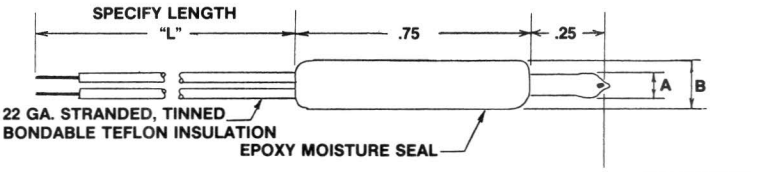
- Non-standard probe lengths.
- Welded or soldered extension leads — specify lead material, lead diameter, length and insulation, if any.
- Calibration at Liquid Nitrogen Point.
- Calibration over range 0°C to -140°C — specify points.
- NBS calibration and test report.
- Interchangeable matched pairs.
- Special housings or enclosures.

TABLE I — STANDARD TOLERANCES

Tolerance Code Letter	K	L	M	N	P	Q	R	S
± % Tolerance @ -196°C	10	15	20	25	30	40	50	Non-Standard (Specify value)

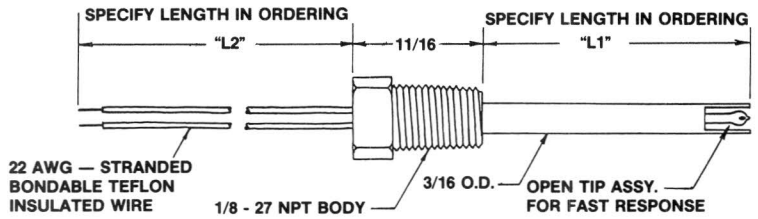
FOR SERIES CTP... OR CTFP...
CYROGENIC THERMOPROBES

A105

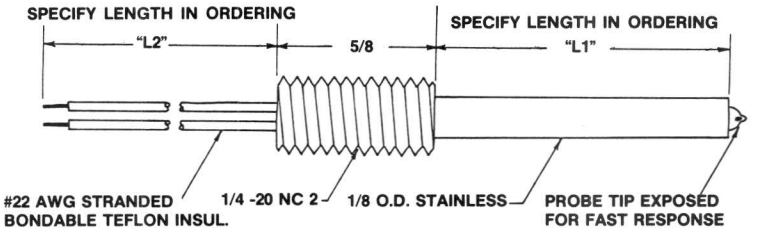


A = .085 MAX.
B = .140 ± .015

A620



A721



ORDERING INFORMATION

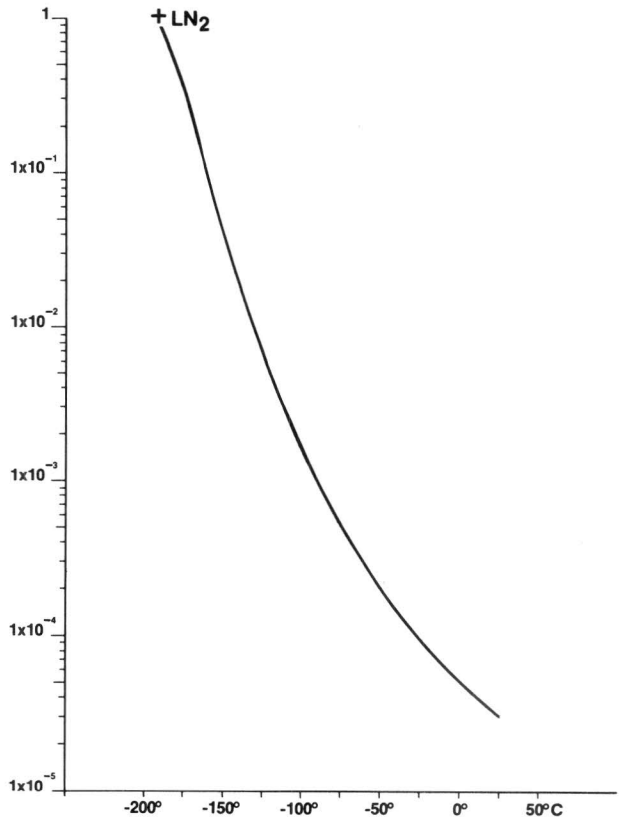
(SAMPLE)

A 620 CTP 60 B E 104 R

- R — TOLERANCE CODE LETTER PER TABLE 1
- 104 — ZERO POWER RESISTANCE CODE, FROM TABLE
- E — MATERIAL SYSTEM CODE LETTER (ALL CRYOGENIC THERMISTORS = E)
- B — PROBE LENGTH CODE LETTER B = 1/4", D = 1/2"
- 60 — THERMISTOR SERIES
- CTP — ASSEMBLY OPTION (AS REQUIRED)
- A 620 —

RESISTANCE RATIO -vs- TEMPERATURE CHARACTERISTIC

-195.82° = 1.0000	-85° = .00073512
	-80° = .00059637
-195° = .97129037	-75° = .00048810
-190° = .75784916	-70° = .00040283
-185° = .54321686	-65° = .00033510
-180° = .37080903	-60° = .00028084
-175° = .24676085	-55° = .00023703
-170° = .16254994	-50° = .00020139
-165° = .10705529	-45° = .00017219
-160° = .07094719	-40° = .00014811
-155° = .04750487	-35° = .00012811
-150° = .03221784	-30° = .00011141
-145° = .02216270	-25° = .00009739
-140° = .01547439	-20° = .00008554
-135° = .01096864	-15° = .00007547
-130° = .00789193	-10° = .00006688
-125° = .00576173	- 5° = .00005952
-120° = .00426633	- 0° = .00005317
-115° = .00320214	+ 5° = .00004768
-110° = .00243470	+10° = .00004291
-105° = .00187414	+15° = .00003875
-100° = .00145960	+20° = .00003510
- 95° = .00114941	+25° = .00003190
- 90° = .00091467	— — — — —



THERMOMETRICS INC.

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CHIP THERMISTOR

SERIES C100

Thermometrics series C100 THERMOCHIPS are low cost, epoxy coated, chip thermistors which represent the highest level of Thermistor technology. Thermometrics exclusive "State-of-the-Art" materials processing techniques have been proven through extensive field use and long term testing to provide stable, rugged, easy handling thermistors suitable for applications in the temperature range of -80° C to + 150° C.*

THERMOCHIPS are well suited for temperature measurement, control and compensation applications. Their low cost makes them ideal for high volume applications such as energy management systems, small appliance controls, automotive and industrial equipment controls. The units exhibit faster still air response times than comparable glass probe devices while maintaining a relatively high dissipation constant and are manufactured to closer resistance tolerances. The maximum power level is .075 watt at 25° C.

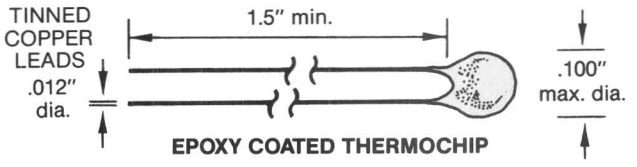
Series C100 THERMOCHIPS are available in a number of standard resistance values ranging from 2000 Ohms up to 300 Kilohms and have standard tolerances at 25° C of either ±5% or ±10% (See Table 1).

*Best stability is achieved at temperatures not exceeding 105° C.

Options:

The following options are available on special order.

- Non Standard Resistance Values
- Non Standard Tolerances
- Reference Temperature(s) other than 25° C.
- Special Mountings and Enclosures
- Non Standard Extension Leads — specify type and length
- Calibration



EPOXY COATED THERMOCHIP

THERMAL AND ELECTRICAL PROPERTIES:

DISSIPATION CONSTANT:	(STILL AIR)	1 mW/° C
	(STIRRED OIL)	8 mW/° C
THERMAL TIME CONSTANT:	(STILL AIR)	10 SEC.
	(STIRRED OIL)	1 SEC.

MAXIMUM POWER RATING:
.075 WATTS (DERATED FROM 100% AT 25° C TO 0% AT 100° C)

TABLE 1

Resistance @ 25° C (Ohms)	Resistance Ratio R0° C/R70° C	Material System Code	Part Number Res. tol. = ±5% @ 25° C	Part Number Res. tol. = ±10% @ 25° C
2,000	18.64	F	C100F202J	C100F202K
2,252	18.64	F	C100F232J	C100F232K
3,000	18.64	F	C100F302J	C100F302K
5,000	18.64	F	C100F502J	C100F502K
6,000	18.64	F	C100F602J	C100F602K
7,000	18.64	F	C100F702J	C100F702K
10,000	18.64	F	C100F103J	C100F103K
10,000	14.84	Y	C100Y103J	C100Y103K
15,000	18.64	F	C100F153J	C100F153K
20,000	18.64	F	C100F203J	C100F203K
30,000	17.75	H	C100H303J	C100H303K
100,000	14.84	Y	C100Y104J	C100Y104K
300,000	25.40	L	C100L304J	C100L304K

Ordering Information:

Select resistance value desired at 25° C and then select corresponding part number for either 5% or 10% tolerance.

For Non Standard parts
please consult factory for part number and pricing.

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RESISTANCE RATIO VS. TEMPERATURE CHARACTERISTICS

Nominal Curves
($R_T/R_{25}°C$)

TEMPERATURE	"F" CURVE	"Y" CURVE	"H" CURVE	"L" CURVE
0°C	3.2651	2.9588	3.1785	3.6267
5	2.5391	2.3515	2.4885	2.7650
10	1.9898	1.8813	1.9619	2.1227
15	1.5710	1.5148	1.5572	1.6410
20	1.2492	1.2271	1.2440	1.2770
25	1.0000	1.0000	1.0000	1.0000
30	0.8057	0.8195	0.8087	0.7880
35	0.6531	0.6752	0.6578	0.6247
40	0.5327	0.5593	0.5380	0.4980
45	0.4369	0.4656	0.4424	0.3993
50	0.3603	0.3894	0.3657	0.3218
55	0.29866	0.3273	0.3038	0.2607
60	0.24882	0.2762	0.2535	0.2123
65	0.20828	0.2342	0.2126	0.1737
70	0.17517	0.19937	0.17908	0.14283
75	0.14793	0.17040	0.15148	0.11797
80	0.12551	0.14620	0.12868	0.09783
85	0.10698	0.12591	0.10974	0.08150
90	0.09153	0.10883	0.09396	0.06817
95	0.07865	0.09439	0.08074	0.05727
100	0.06784	0.08214	0.06964	0.04827
105	0.05874	0.07171	0.06027	0.04083

TO FIND THE THERMISTOR RESISTANCE
AT ANY SPECIFIED TEMPERATURE
SELECT THE CURVE CORRESPONDING TO THE
MATERIAL SYSTEM CODE LETTER SHOWN IN TABLE 1
THEN MULTIPLY THE TABLE VALUE
BY THE RESISTANCE AT 25°C

THERMOMETRICS INC.

The Source of Thermistor Expertise

hybrid microcircuit thermistor chip

STYLE:

Thermometrics series HM Thermochips are leadless, bare chip thermistors with top and bottom metallized surface contacts. Series HM Thermochips are manufactured using Thermometrics' exclusive "State-of-the-Art" materials processing techniques. The result is a low-cost, rugged and stable thermistor chip with performance that has been proven in field use and long term testing. The series HM Thermochips come with top and bottom electrode surfaces of fired-on silver-palladium alloy. Sizes of the series HM Thermochips range from .025" x .025" up to .085" x .085" for the standard resistance values shown. Standard HM Thermochip thicknesses are .010" or .015" as shown. Other sizes, thicknesses, resistance values and electrode materials may be specified upon special order.

APPLICATIONS:

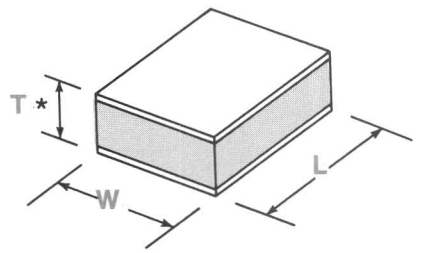
Series HM Thermochips are designed for mounting on hybrid substrates, integrated circuits or printed circuit boards. The small sizes and low mounting profile makes them a suitable choice for temperature compensation or control in hybrid circuits. They are also used for spot temperature sensing and circuit over temperature protection. The series HM Thermochips may be mounted to the substrate or printed circuit by conductive epoxy bonding or by soldering. A lead wire is then attached to complete the electrical circuit connection.

MAXIMUM TEMPERATURE:

Series HM Thermochips may be used over the temperature range of -80° C to +150° C; however, best stability will be achieved if the operating or storage temperatures are limited to +105° C or lower. The series HM thermochips are bare chip thermistors and so it is important to consider the effects of the operating or storage environment on the thermistor. Suitable protection must be provided for the thermistor against the effects of harsh environments during operation or storage.

OPTIONS:

- Non-standard resistance values
- Non-standard sizes
- Non-standard electrode materials (Gold)
- Special electrode surface preparation (tinning, etc.)
- Non-standard reference temperature(s)
- Non-standard resistance tolerances



THERMAL AND ELECTRICAL PROPERTIES:

(thermal time constant)	10-45 sec. in still air at 25° C.
(dissipation constant)	7-15 mW/° C in still air at 25° C.

The thermal time constant and dissipation constant values are dependent upon the method of mounting. The above values represent the range of nominal values for the smallest to largest series HM thermistor chips when soldered to an alumina substrate .025" thick using 2% silver solder.

TABLE 1

Resistance @ 25° C (ohms)	Resistance Ratio (R0° C/R70° C)	Material System Code Letter	Dimensions (In Inches) Width W	Length L	Thick T*	Part Number ± 5% tol. on Resistance @ 25° C	Part Number ± 10% tol. on Resistance @ 25° C
2,252	18.64	F	.070	.070	.010	HM70NF232J	HM70NF232K
2,252	18.64	F	.085	.085	.015	HM85NF232J	HM85NF232K
3,000	18.64	F	.060	.060	.010	HM60NF302J	HM60NF302K
3,000	18.64	F	.075	.075	.015	HM75NF302J	HM75NF302K
5,000	18.64	F	.050	.050	.010	HM50NF502J	HM50NF502K
5,000	18.64	F	.060	.060	.015	HM60NF502J	HM60NF502K
10,000	18.64	F	.035	.035	.010	HM35NF103J	HM35NF103K
10,000	18.64	F	.040	.045	.015	HM40NF103J	HM40NF103K
10,000	14.84	Y	.045	.045	.010	HM45NY103J	HM45NY103K
10,000	14.84	Y	.055	.055	.015	HM55NY103J	HM55NY103K
30,000	17.75	H	.025	.025	.010	HM25NH303J	HM25NH303K
30,000	17.75	H	.030	.035	.015	HM30NH303J	HM30NH303K
100,000	14.84	Y	.030	.030	.010	HM30NY104J	HM30NY104K
100,000	14.84	Y	.035	.035	.015	HM35NY104J	HM35NY104K

*Does not include electrode thickness.
Standard electrodes are .001" thick silver-palladium alloy.

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RESISTANCE RATIO VS. TEMPERATURE CHARACTERISTICS

Nominal Curves
($R_T/R_{25}°C$)

TEMPERATURE	"F" CURVE	"Y" CURVE	"H" CURVE
0° C	3.2651	2.9588	3.1785
5	2.5391	2.3515	2.4885
10	1.9898	1.8813	1.9619
15	1.5710	1.5148	1.5572
20	1.2492	1.2271	1.2440
25	1.0000	1.0000	1.0000
30	0.8057	0.8195	0.8087
35	0.6531	0.6752	0.6578
40	0.5327	0.5593	0.5380
45	0.4369	0.4656	0.4424
50	0.3603	0.3894	0.3657
55	0.29866	0.3273	0.3038
60	0.24882	0.2762	0.2535
65	0.20828	0.2342	0.2126
70	0.17517	0.19937	0.17908
75	0.14793	0.17040	0.15148
80	0.12551	0.14620	0.12868
85	0.10698	0.12591	0.10974
90	0.09153	0.10883	0.09396
95	0.07865	0.09439	0.08074
100	0.06784	0.08214	0.06964
105	0.05874	0.07171	0.06027

TO FIND THE THERMISTOR RESISTANCE
AT ANY SPECIFIED TEMPERATURE
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BY THE RESISTANCE AT 25° C

THERMOMETRICS INC.

The Source of Thermistor Expertise

THERMISTOR DISCS

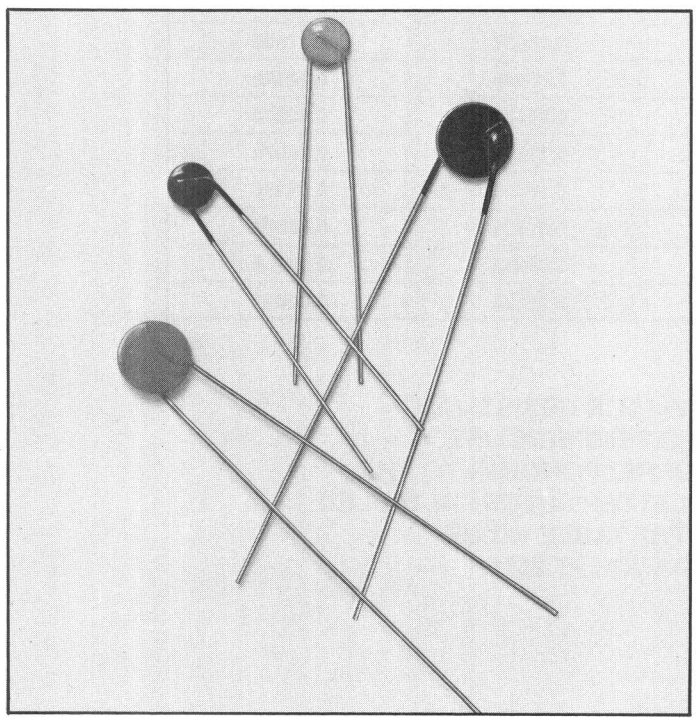
LOW COST

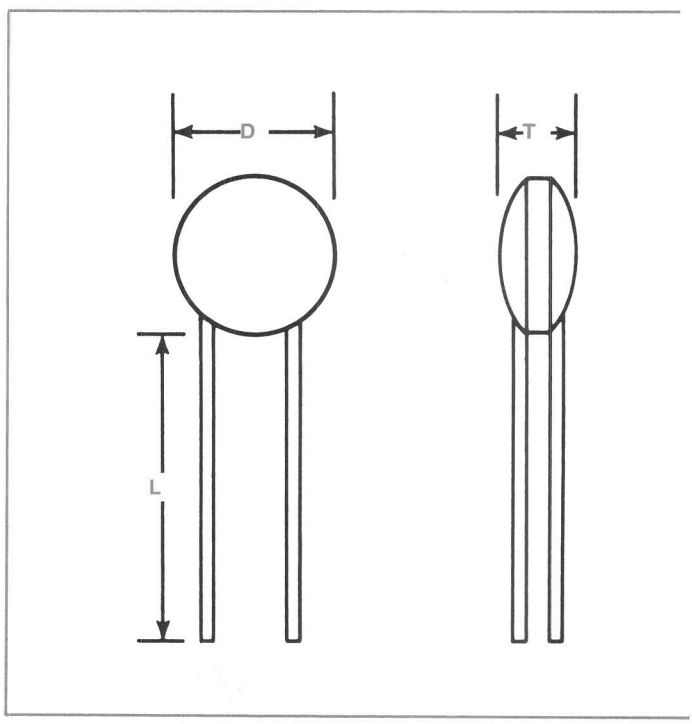
Thermometrics, Inc. D320, D200, and D120 series thermistors are very low cost, large size, epoxy coated disc devices with greater power handling capabilities than series C100C Chips making them ideally suited for many temperature compensation, current limiting, and delay circuit applications.

These NTC devices are available in a wide range of resistance values @ 25° C ranging from 13 ohms to 400 kilohms with tolerances of either ± 15% o ± 20% depending on devices selected.

See Table 1 for part numbers and specifications on units currently available.

For more information or for assistance with you application, please contact Thermometrics Appli cations Engineering Department.





THERMISTOR DISCS

TABLE 1 SPECIFICATIONS AND ORDERING INFORMATION

Types	Resistance R_T at 25°C (Ω)	Tolerance %	Max. Allowable Current (mA)	β Constant (K)	Temp. Coef. (α) (%/°C)	Dissipation Const. at 25°C (mW/°C)	All Dimensions In Inches D	T Max	L Min.	Types	Resistance R_T at 25°C (Ω)	Tolerance %	Max. Allowable Current (mA)	β Constant (K)	Temp. Coef. (α) (%/°C)	Dissipation Const. at 25°C (mW/°C)	All Dimensions In Inches D	T Max	L Min.
D320A130M	13	20	850	3,100	—3.5	7	.320	.200	1.75	D200A401L	400	15	120	3,100	—3.5	4.5	.200	.200	1.10
D320A200M	20	20	690	3,100	—3.5	7	.320	.200	1.75	D200A501L	500	15	111	3,100	—3.5	4.5	.200	.200	1.10
D320A300M	30	20	560	3,100	—3.5	7	.320	.200	1.75										
D320A400L	40	15	480	3,100	—3.5	7	.320	.200	1.75	D200B651L	650	15	130	3,800	—4.3	4.5	.200	.200	1.10
D320A500L	50	15	387	3,100	—3.5	7	.320	.200	1.75	D200B102L	1,000	15	105	3,800	—4.3	4.5	.200	.200	1.10
D320A600L	60	15	353	3,100	—3.5	7	.320	.200	1.75	D200B152L	1,500	15	85	3,800	—4.3	4.5	.200	.200	1.10
D320A800L	80	15	345	3,100	—3.5	7	.320	.200	1.75	D200B202L	2,000	15	74	3,800	—4.3	4.5	.200	.200	1.10
D320A131L	130	15	271	3,100	—3.5	7	.320	.200	1.75	D200B252L	2,500	15	69	3,900	—4.4	4.5	.200	.200	1.10
D320A252L	2,500	15	61	3,100	—3.5	7	.320	200	1.75	D200B302L	3,000	15	63	3,900	—4.4	4.5	.200	.200	1.10
										D200B402L	4,000	15	54	3,900	—4.4	4.5	.200	.200	1.10
D200A700L	70	15	290	3,100	—3.5	4.5	.200	.200	1.10	D200B502L	5,000	15	49	3,900	—4.4	4.5	.200	.200	1.10
D200A900L	90	15	261	3,100	—3.5	4.5	.200	.200	1.10	D200B682L	6,800	15	42	3,900	—4.4	4.5	.200	.200	1.10
D200A101L	100	15	248	3,100	—3.5	4.5	.200	.200	1.10	D200B103L	10,000	15	39	4,200	—4.4	4.5	.200	.200	1.10
D200A121L	120	15	226	3,100	—3.5	4.5	.200	.200	1.10	D200B203L	20,000	15	27	4,200	—4.7	4.5	.200	.200	1.10
D200A151L	150	15	202	3,100	—3.5	4.5	.200	.200	1.10	D200B303L	30,000	15	17	4,200	—4.7	4.5	.200	.200	1.10
D200A201L	200	15	176	3,100	—3.5	4.5	.200	.200	1.10	D200B104L	100,000	15	15	4,500	—5.1	4.5	.200	.200	1.10
D200A221L	220	15	168	3,100	—3.5	4.5	.200	.200	1.10										
D200A251L	250	15	157	3,100	—3.5	4.5	.200	.200	1.10	D120B404L	400,000	15	5.7	4,500	—5.1	3.0	.120	.120	1.75
D200A271L	270	15	152	3,100	—3.5	4.5	.200	.200	1.10										
D200A301L	300	15	146	3,100	—3.5	4.5	.200	.200	1.10										

Note: Tolerance of Resistance is ± 15% and Tolerance of B Constant is ± 7%.
But in case of R_{25} =30 Ω or less, the former is ± 20% and the latter is ± 10%.
Other ratings and specifications are available.

THERMOMETRICS INC.
The Source of Thermistor Expertise

DIODE PACKAGE CHIP THERMISTORS

SERIES DP70

Description:
Thermometrics, Inc. DP70 thermistors are NTC chip type thermistors sealed in glass diode packages. Their design combines the advantages of higher temperature ratings (to 300° C) and better reliability found in glass sealed units with the lower cost and closer tolerances associated with chip devices.

The axial leaded glass diode package is ideally suited for circuit board mounting and can be ordered with taped lead and reel dispensing for high volume industrial/ commercial applications.

The units are available in resistance values at 25° C of 10 ohms, 20k ohms, 50k ohms and 100k ohms with tolerance of ± 5% or ± 10%.

Thermal and Electrical Properties:

Dissipation Constant: (still air) 2.0 mW/°
Thermal Time Constant: (still air) 25 sec. (max
Operating Temperature: -40° C to 300° C
Maximum Power Rating: 200 mW
(Derated from 100% at 25° C to 0% at 300° C)
Leads: Plated Copper

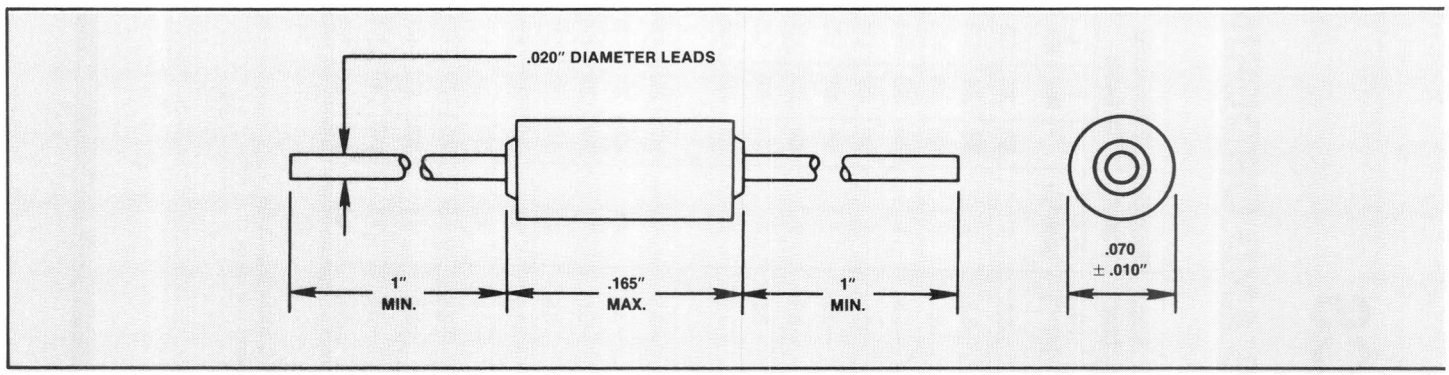


TABLE 1

Ordering information and specifications

Part Number	Resistance, @ 25° C	Tolerance ± %	Beta ± 5% (25° C - 50° C)
DP70B103J	10,000 ohms	± 5%	3700
DP70B103K	10,000 ohms	± 10%	3700
DP70B203J	20,000 ohms	± 5%	3700
DP70B203K	20,000 ohms	± 10%	3700
DP70B503J	50,000 ohms	± 5%	3900
DP70B503K	50,000 ohms	± 10%	3900
DP70B104J	100,000 ohms	± 5%	3900
DP70B104K	100,000 ohms	± 10%	3900

UNITHERM THERMISTORS

WHY USE THERMOMETRICS INTERCHANGEABLE UNITHERM THERMISTORS?

THERMOMETRICS *Unitherm Thermistors* are completely *interchangeable*. They permit the design engineer to freeze a circuit design and so eliminate the need for costly circuit adjustment, padding or calibration. Complete standardization is possible, minimizing maintenance or field replacement problems. The unit you purchase five or ten years from now will be identical to the one you use for today's design. There is a THERMOMETRICS *Unitherm Thermistor* to suit every temperature measurement, control or compensation application in the range of −140°C to +300°C (−220°F to +572°F).

UNITHERM GROUPS

Group A Unitherm Thermistors consist of matched pairs of glass beads, probes or rods. Although each thermistor is not necessarily a close tolerance unit, the pairs are combined in series or parallel to have completely interchangeable resistance vs. temperature curves over the entire temperature range selected to within the tolerance specified. Group A units which have been connected in *series* are identified as *Types S, T, or R*. Group A units which have been connected in parallel are identified as *Types P, N or X*. They are described in detail on page **I-3**.

Group B are single unit Unitherm Thermistors which exhibit completely interchangeable resistance vs. temperature curves over the entire temperature range specified.

Group C Unitherm Thermistors are single thermistors which have completely interchangeable resistance ratio vs. temperature characteristics over a specified temperature range. These units provide the designer with a low cost means of obtaining interchangeability. By matching a bridge or voltage divider resistor to the thermistor resistance at a specified reference temperature, complete circuit interchangeability can be obtained to within the tolerance specified for the resistance ratio characteristic.

RESISTANCE-TEMPERATURE CHARACTERISTIC

The resistance-temperature characteristic of a thermistor can be expressed as $R_T = R_{T0} \bullet r(T)$ where T_0 is a reference temperature, R_{T0} is the resistance at the reference temperature and r(T) is the *resistance ratio* characteristic normalized with respect to T_0 (i.e., $r(T_0) = 1$). Most manufacturers specify a nominal value and a percent tolerance for R_{T0} at a standard reference temperature of 25°C. A tolerance for r(T) (resistance ratio) is seldom provided. Only the nominal resistance ratio characteristic is generally specified. The tolerance for this characteristic is dependent on the control of materials and processing used. At THERMOMETRICS the greatest possible control is exercised. We even manufacture our own raw materials.

The conduction mechanism for thermistors is such that the tolerance on r(T) increases as the temperature deviation from the reference temperature increases. Even with good control, standard manufacturing tolerances can result in large uncertainties for applications which require wide temperature ranges. This is illustrated in Table 1 which shows the tolerance in r(T) permitted by MIL-T-23648 when R_{T0} has a ± 1% tolerance at 25°C. This table dramatically illustrates the need for THERMOMETRICS *Unitherm Thermistors* when close tolerance interchangeability is a requirement.

Table 1 — MIL-T-23648 Resistance Tolerance vs. Temperature

Temperature (°C)	−55	−15	0	25	50	75	100	125	200	275
Tolerance (±%)	10	5	3	1	3	5	7	10	15	20

UNITHERM TOLERANCES

Standard tolerances for THERMOMETRICS *Unitherm Thermistors* are shown in Table 2. The curve tolerance may be specified as a temperature deviation or a percentage of resistance or resistance ratio. For standard catalog items, which are stocked, the tolerance specified applies to all temperatures within the selected range. Although various tolerances are stocked for specific temperature ranges, it is more economical to specify the actual tolerance vs. temperature required for any specific application. For example, the

US BR16KB443ACB5HA

is a standard item which follows a specified curve to within ± 0.05°C between 25 and 50°C. The same unit with a ± 0.05°C tolerance for the range of 33 to 43°C and a tolerance of ± 0.1°C at all other temperatures in the ranges of 25 to 50°C would be significantly lower in cost. This is particularly true for large quantity applications.

TABLE 2 — STANDARD TOLERANCES*

TOLERANCE CODE LETTER	A	B	C	D	E	F	G	H	J	K	S
± DEVIATION FROM NOMINAL	.05	.1	.2	.25	.5	1	2	3	5	10	Non-standard specify value

*The interchangeability tolerance is expressed by means of a single or double code. The first letter, given in Table 2, designates the maximum deviation from the nominal curve. A letter C following the first letter is used to denote a deviation in °C. A letter F following the first denotes °F. A single letter code denotes percentage of reading.

RESISTANCE TOLERANCE VS. TEMPERATURE TOLERANCE

Most thermistors have negative temperature coefficients of resistance (TCR) which are in the range of 3 - 5%/°C at 25°C. In general, the higher resistance units have higher coefficients. Unlike resistors, however, the TCR values for thermistors are not constant but vary approximately as $1/K^2$ where K is absolute temperature in Kelvins (K = °C + 273.15). Therefore, if a fixed value is specified for the temperature tolerance over the entire operating range, the resistance tolerance permitted will be lower at higher temperatures and obviously, higher at lower temperatures. Conversely, if the tolerance is specified as a fixed percentage of reading across the entire operating range, the allowable temperature error will be larger at the higher temperatures and vice versa.

TEMPERATURE RANGE

Any temperature within the overall span of −140 to 300°C (−220 to 572°F) may be specified for THERMOMETRICS Unitherm Thermistors. We maintain a large stock of units which are calibrated at standard bath temperatures. The serial number and calibration values for each unit are stored in our computer data files. In order to provide high measurement accuracy the temperature range, for any given thermistor type, must be limited. That temperature which corresponds to a resistance value below 1 megohm becomes the low temperature limit. The high temperature limit is determined at that point where the value of the nominal thermistor resistance is equal to 1,000 times the lead resistance. When temperature range limits are specified at points other than those used for calibration, the computer performs a polynomial regression analysis and calculates the resistance values at the specified points. The uncertainty of this computation is less than 0.005°C. When the temperature range, tolerance, type of interchangeability and circuit configuration are fed into the computer, the appropriate units are selected and identified. For a specified tolerance, a narrower range results in higher yield and lower cost. Similarly, a broader tolerance, for a specified range, also results in lower costs.

SELECTION & ORDERING INFORMATION

The following parameters must be specified when ordering Unitherm Thermistors:

1. **Unitherm Sensor Assembly (if required)**
When thermistors are not mounted directly to circuit boards or to customer product surfaces, they ultimately are assembled into any of a large variety of metal or plastic housings or tubes to suit the individual application needs. Thermometrics produces a complete line of housings to meet special requirements. Since almost all of the hardware is stocked, there are no set-up charges involved. A full range of the most commonly used configurations are shown in our Sensor Catalog & Handbook. Immersion probes, catheter and needle subassemblies, threaded fittings, biomedical probes, and air probes are all included. Electrical connector terminations or wire leads of any desired length are also available.

2. **Thermistor Selection**
The choice of thermistor is dictated by the specific application requirements. Factors which should be considered are space or volume available, power level, time response, maximum temperature, stability and cost.

RUGGEDIZED BEADS (Thermobead Series BR) are small glass enclosed beads which offer fast response, good stability and high temperature operation to 300°C. They are available in sizes ranging from 0.011" diameter on 0.0007" wires to 0.055" diameter on 0.004" diameter wires. Larger diameter extension leads are available.

GLASS PROBES (Thermobead Series P) are the most stable and reliable thermistors available. They are used when a more rugged, longer configuration is desired. Glass probes are available in sizes ranging from 0.020" diameter x 0.125" long on 0.001" wires to 0.1" diameter x 2" long on 0.012" wires. Larger diameter probes (0.060" - 0.1") have tinned dumet leads which can be readily attached to circuit boards or extension leads.

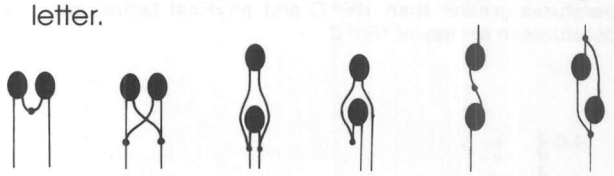
EPOXY COATED CHIPS Series C50, 75, & 100 are the lowest cost interchangeable thermistors available. Since they are not sealed in glass, chips may not be operated above 150°C. For maximum stability, the temperature should not exceed 100°C. Leads are generally 0.008" or 0.012" diameter and can be easily handled. Chips are most frequently used in the range of 0 to 70°C and offer a good compromise between stability and cost.

RESISTANCE AT 25°C is dictated by the operating temperature range specified. To minimize noise pick-up and measurement problems, the resistance at the lower temperature limit should generally be kept below 100K ohms. The resistance at the upper temperature limit should be high enough so that the thermistor lead resistance is negligible compared with the resistance change corresponding to the tolerance specified.

3. **UNITHERM GROUPS**

UA	Matched thermistor pairs, supplied loose.
US	Matched pair, connected in series, side by side configuration
UP	Matched pair, connected in parallel, side by side configuration
UN	Matched pair, connected in parallel, tandem configuration
UT	Matched pair, connected in series, tandem configuration
UR	Matched pair, connected in series, radial lead configuration
UX	Matched pair, connected in parallel, radial lead configuration
UB	Single thermistor, R-vs-T matched over a given range of temperatures
UC	Single thermistor, Ratio matched over a given temperature range.

4. **NETWORK CONFIGURATION,** specify figure letter.



5. **TOLERANCE AND TEMPERATURE RANGE**
Specify the temperature range desired and the tolerance required over the entire range or portions of the range. (See Table 2)

6. **Price and Delivery:** submit above information to our Applications Engineering staff and price and delivery will be quoted.

UNITHERM THERMOCHIP

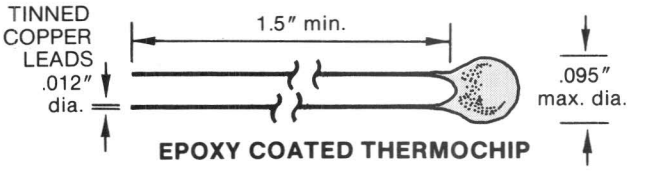
epoxy coated interchangeable

STYLE:
Unitherm Interchangeable Thermistors, Thermometrics' Series DC95F, are manufactured using proven materials and techniques, making it possible to obtain close tolerances and resistance-temperature curve tracking at a low cost. The performance of THM's DC95F has been substantiated by extensive field use and long-term testing. The result is a rugged, stable and easy-to-handle device. All Series DC95F thermistors are epoxy-coated for stability and have a maximum diameter of .095 inch. Standard leads are 1½ inches x .012 inches diameter. Standard resistance values at 25° C are 2252Ω, 3000Ω, 5000Ω, and 10,000Ω. Each unit tracks a specified curve to within ±0.1° C or ±0.2° C over the temperature range of 0° C to 70° C. Only ±0.2° C curve tracking is available over the temperature range of 0° C to 100° C. Narrower temperature ranges may be specified for effective cost savings or to accomplish even tighter curve tracking tolerances.

APPLICATIONS:
Unitherm Interchangeable Thermistors, Series DC95F, are designed for close tolerance resistance-temperature curve tracking over two standard temperature ranges. As such, they may be used in any general temperature measurement, control or compensation application where interchangeability and low cost are major considerations. Chip-style thermistors, such as the Series DC95F, have higher dissipation constants than glass-coated beads or probe-style thermistors and therefore can be used in circuits where there are moderate power levels. The thermal time constant for chip-style thermistors is comparable to that of large glass probes. The Series DC95F chip thermistor is especially suitable for disposable and permanent medical product usage, as well as in energy management systems, appliances, industrial equipment and automotive applications. Series DC95F thermistors are available in a large variety of sensor configurations and housings. Contact the factory for specific design or application information on mountings or enclosures.

MAXIMUM TEMPERATURE:
Series DC95F thermistors are designed to be interchangeable over 0° C to 70° C and 0° C to 100° C. They may be used at temperatures as low as -80° C and as high as 150° C, however, best overall stability is achieved with exposure or storage temperatures lower than 105° C. Resistance shifts and degraded stability will result if the devices are subjected to temperatures greater than 105° C and physical failure may result at temperatures in excess of 150° C.

OPTIONS:
- Non-standard resistance values.
- Non-standard temperature ranges (-80° C to 150° C limits).
- Non-standard interchangeability tolerances.
- Extension leads, specify length, materials etc.
- Special mounting or enclosures.
- Calibration - specify temperatures.



EPOXY COATED THERMOCHIP

THERMAL AND ELECTRICAL PROPERTIES:

DISSIPATION CONSTANT:	(STILL AIR)	1 mW/° C
	(STIRRED OIL)	8 mW/° C
THERMAL TIME CONSTANT:	(STILL AIR)	10 SEC.
	(STIRRED OIL)	1 SEC.

MAXIMUM POWER RATING:
.075 WATTS (DERATED FROM 100% AT 25° C TO 0% AT 100° C)

ORDERING INFORMATION:

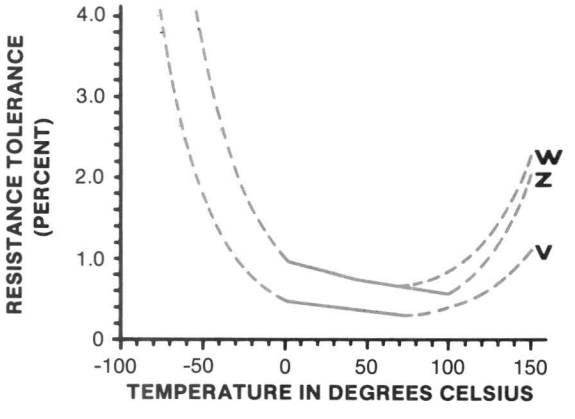
D C 9 5 F — —

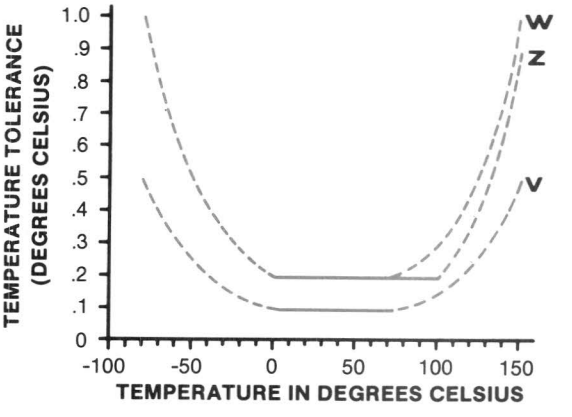
SERIES:
EPOXY COATED CHIP
.095″ MAX. DIA.

MATERIAL SYSTEM:
29.27 = 25° C/125° C RATIO
18.64 = 0° C/70° C RATIO
9.06 = 0° C/50° C RATIO

TOLERANCE CODE AND TEMPERATURE RANGE:
V = ±0.1° C - 0° C/70° C
W = ±0.2° C - 0° C/70° C
Z = ±0.2° C - 0° C/100° C

RESISTANCE CODE:
232 = 2252 OHMS
302 = 3000 OHMS
502 = 5000 OHMS
103 = 10000 OHMS





THERMOMETRICS 808 U.S. HIGHWAY #1 • EDISON, NEW JERSEY 08817 • (201) 287-2870 • TELEX 844-387

RESISTANCE VS. TEMPERATURE CHARACTERISTICS

temp °C	2252 Ω	3K Ω	5K Ω	10K Ω
−55	217036	289125	481875	963749
−54	201609	268574	447623	895245
−53	187379	249617	416028	832055
−52	174245	232120	386867	773734
−51	162116	215963	359938	719877
−50	150910	201035	335058	670115
−49	140550	187234	312057	624114
−48	130968	174469	290782	581565
−47	122101	162657	271094	542189
−46	113891	151719	252865	505731
−45	106284	141587	235978	471956
−44	99234.8	132196	220326	440652
−43	92697.4	123487	205811	411622
−42	86632.0	115407	192345	384689
−41	81001.8	107906	179844	359688
−40	75773.0	100941	168235	336470
−39	70914.6	94468.8	157448	314896
−38	66398.2	88452.3	147420	294841
−37	62197.6	82856.5	138094	276188
−36	58289.1	77649.8	129416	258833
−35	54650.5	72802.6	121338	242675
−34	51261.7	68288.2	113814	227627
−33	48104.0	64081.7	106803	213606
−32	45160.4	60160.4	100267	200535
−31	42413.4	56501.2	94168.8	188337
−30	39853.5	53090.9	88484.8	176970
−29	37457.4	49899.9	83166.6	166333
−28	35228.0	46929.3	78215.6	156431
−27	33143.3	44151.8	73586.4	147173
−26	31193.4	41554.2	69257.0	138514
−25	29370.0	39125.3	65208.8	130418
−24	27659.5	36847.3	61412.2	122824
−23	26061.2	34716.9	57861.5	115723
−22	24573.5	32735.6	54559.4	109119
−21	23173.7	30870.9	51451.4	102903
−20	21862.1	29123.5	48539.2	97078.5
−19	20632.5	27485.6	45809.4	91618.8
−18	19479.5	25949.6	43249.4	86498.8
−17	18397.8	24508.7	40847.8	81695.6
−16	17382.7	23156.3	38593.8	77187.7
−15	16429.6	21886.6	36477.7	72955.4
−14	15534.4	20694.1	34490.1	68980.3
−13	14693.2	19573.6	32622.7	65245.3
−12	13402.6	18520.4	30867.3	61734.6
−11	13159.2	17530.1	29216.8	58433.6
−10	12460.0	16598.5	27664.2	55328.4
− 9	11801.9	15722.0	26203.3	52406.5
− 8	11182.5	14896.8	24828.0	49656.0
− 7	10599.2	14119.8	23533.0	47065.9
− 6	10049.8	13387.8	22313.0	44626.1
− 5	9532.00	12698.1	21163.4	42326.8
− 4	9043.90	12047.8	20079.7	40159.4
− 3	8583.62	11434.7	19057.8	38115.5
− 2	8149.42	10856.2	18093.7	36187.5
− 1	7739.68	10310.4	17184.0	34368.0
0	7352.90	9795.16	16325.3	32650.5
1	6988.42	9309.62	15516.0	31032.1
2	6643.38	8849.98	14750.0	29499.9
3	6317.41	8415.73	14026.2	28052.4
4	6009.39	8005.39	13342.3	26684.6
5	5718.10	7617.37	12695.6	25391.2
6	5442.68	7250.46	12084.1	24168.2
7	5182.12	6903.35	11505.6	23011.2
8	4935.54	6574.88	10958.1	21916.3
9	4702.12	6263.93	10439.9	20879.8
10	4481.09	5969.48	9949.14	19898.3
11	4271.72	5690.57	9484.28	18968.6
12	4073.33	5426.28	9043.80	18087.6
13	3885.28	5175.78	8626.30	17252.6
14	3706.99	4938.27	8230.45	16460.9
15	3537.90	4713.01	7855.01	15710.0
16	3377.47	4499.30	7498.83	14997.7
17	3225.23	4296.48	7160.80	14321.6
18	3080.70	4103.95	6839.92	13679.8
19	2943.46	3921.13	6535.22	13070.4
20	2813.11	3747.48	6245.80	12491.6
21	2689.26	3582.49	5970.82	11941.6
22	2571.54	3425.68	5709.47	11418.9
23	2459.64	3276.61	5461.01	10922.0
24	2353.22	3134.84	5224.74	10449.5
25	2252.00	3000.00	5000.00	10000.0

temp °C	2252 Ω	3K Ω	5K Ω	10K Ω
25	2252.00	3000.00	5000.00	10000.0
26	2155.69	2871.70	4786.16	9572.32
27	2064.02	2749.59	4582.64	9165.29
28	1976.76	2633.34	4388.89	8777.79
29	1893.67	2522.10	4204.34	8408.68
30	1814.51	2417.19	4028.66	8057.31
31	1739.09	2316.73	3861.22	7722.43
32	1667.22	2220.99	3701.65	7403.29
33	1598.51	2129.52	3549.20	7098.42
34	1533.20	2042.50	3404.18	6808.36
35	1470.89	1959.39	3265.65	6531.31
36	1411.58	1880.47	3134.12	6265.75
37	1354.91	1804.94	3008.23	6016.47
38	1300.77	1732.82	2888.03	5776.05
39	1249.08	1663.96	2773.26	5546.53
40	1199.72	1598.20	2663.67	5327.34
41	1152.57	1535.39	2558.99	5117.97
42	1107.52	1475.38	2458.97	4917.94
43	1064.47	1418.03	2363.39	4726.77
44	1023.30	1363.17	2271.95	4543.91
45	983.97	1310.80	2184.66	4369.33
46	946.02	1260.25	2100.92	4200.84
47	909.99	1212.24	2020.40	4040.81
48	875.92	1166.85	1944.76	3889.51
49	842.96	1122.95	1871.59	3743.17
50	811.42	1080.93	1801.55	3603.10
51	780.92	1040.30	1733.84	3467.69
52	752.29	1002.17	1670.28	3340.55
53	724.59	965.26	1608.77	3217.54
54	698.03	929.88	1549.80	3099.62
55	672.58	895.97	1493.29	2986.60
56	648.23	863.55	1439.24	2878.49
57	624.83	832.36	1387.27	2774.55
58	602.45	802.56	1337.60	2675.20
59	580.90	773.84	1289.75	2579.52
60	560.34	746.46	1244.10	2488.20
61	540.56	720.11	1200.18	2400.36
62	521.58	694.82	1158.03	2316.05
63	503.35	670.54	1117.57	2235.13
64	485.85	647.22	1078.71	2157.43
65	469.05	624.85	1041.42	2082.84
66	452.92	603.35	1005.59	2011.18
67	437.42	582.70	971.17	1942.35
68	422.52	562.86	938.11	1876.21
69	408.21	543.80	906.33	1812.65
70	394.47	525.70	875.82	1751.65
71	381.22	507.85	846.41	1692.82
72	368.50	490.89	818.16	1636.33
73	356.27	474.61	791.01	1582.02
74	344.50	458.93	764.88	1529.77
75	333.13	443.78	739.64	1479.30
76	322.24	429.27	715.45	1430.90
77	311.74	415.28	692.13	1384.28
78	301.70	401.91	669.86	1339.73
79	292.02	389.02	648.37	1296.74
80	282.64	376.52	627.54	1255.08
81	273.65	364.54	607.57	1215.15
82	265.00	353.02	588.38	1176.76
83	256.67	341.93	569.88	1139.77
84	248.61	331.19	551.98	1103.96
85	240.91	320.93	534.89	1069.79
86	233.35	310.86	518.10	1036.21
87	226.14	301.26	502.10	1004.20
88	219.27	292.10	486.84	973.67
89	212.58	283.19	471.99	943.97
90	206.13	274.60	457.66	915.32
91	199.91	266.31	443.84	887.69
92	193.91	258.31	430.51	861.02
93	188.11	250.59	417.65	835.29
94	182.52	243.14	405.23	810.46
95	177.12	235.96	393.27	786.54
96	171.91	229.00	381.67	763.35
97	166.87	222.30	370.50	741.00
98	162.01	215.82	359.71	719.41
99	157.32	209.57	349.28	698.57
100	152.78	203.53	339.21	678.42
101	148.40	197.69	329.48	658.96
102	144.17	192.05	320.08	640.17
103	140.07	186.59	310.98	621.97
104	136.11	181.32	302.19	604.39
105	132.28	176.22	293.70	587.39

ASSEMBLIES

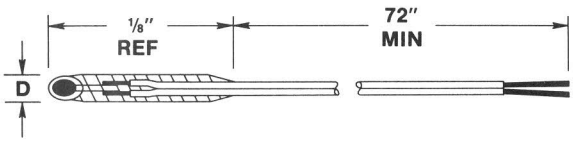
SERIES AB6 THERMOBEAD AND THERMOPROBE ASSEMBLIES

STYLE:

Series AB6 thermistor assemblies consist of small Thermoprobes or Thermobeads which are welded to insulated extension leads. The Thermobeads or Thermoprobes are hermetically sealed in glass and have fine diameter (.0007" to .004") platinum alloy leads. The platinum leads are cut short and welded to insulated extension leads and the joints are covered in one of several insulation types depending upon the application or environment. The assembly is then ready for insertion into hypodermic needles, catheters or other small housings which require extended leads. Any of the Thermobeads or Thermoprobes listed in Table I may be used in a Series AB6 assembly. Please consult the catalog pages shown for specific electrical or mechanical properties for the thermistor selected.

APPLICATIONS:

Thermobead and Thermoprobe assemblies are used where the small thermistor must be further connected to longer leads, for insertion into deep wells and cavities, or threading into long tubes. They may also be used, as is, for applications which require fast response measurements in confined spaces. With these assemblies, the fast response of the small thermistor is available without sacrificing handleability. The added leads and insulation allows the minute assemblies to be handled in further assembly operations, such as insertion into catheter lumens. The same electical characteristics that apply to the selected thermistor: resistance value, resistance ratio, stability; are unaltered in the assembly.



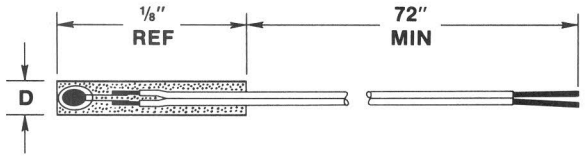
TYPE A INSULATION

AB6A8 -

THERMISTOR WELDED TO 38 GA., NICKEL ALLOY 200, BIFILAR, HEAVY ISOMID INSULATED EXTENSION LEADS, 6½ FT. ± ½ FT. LONG. LIQUID EPOXY RESIN WEB OVER WELD JOINTS PROVIDES SOME STRAIN RELIEF.

FOR INSERTION INTO PLASTIC TUBING OR OTHER INSULATORS.

MAXIMUM CONTINUOUS OPERATING TEMPERATURE 105° C.



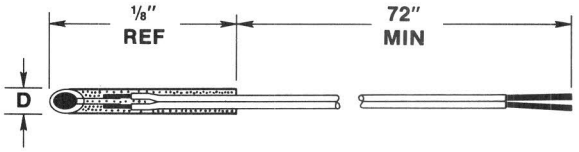
TYPE B INSULATION

AB6B2 -

THERMISTOR WELDED TO 38 GA., NICKEL ALLOY 200, BIFILAR, HEAVY ISOMID INSULATED EXTENSION LEADS, 6½ FT. ± ½ FT. LONG. POLYIMIDE SLEEVE IS EPOXIED OVER WELD JOINTS AND THERMISTOR, FOR STRAIN RELIEF AND INSULATION.

FOR INSERTION INTO METAL HOUSINGS OR TUBINGS. BEAD COVERED FOR MAXIMUM STRAIN RELIEF AND PROTECTION.

MAXIMUM CONTINUOUS OPERATING TEMPERATURE 175° C.



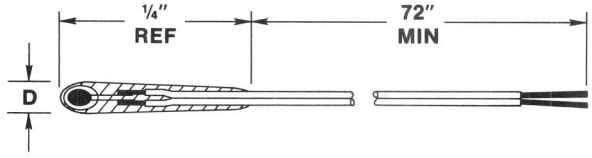
TYPE B INSULATION

AB6B4 -

THERMISTOR WELDED TO 38 GA., NICKEL ALLOY 200, BIFILAR, HEAVY ISOMID INSULATED EXTENSION LEADS, 6½ FT. ± ½ FT. LONG. POLIMIDE SLEEVE IS EPOXIED OVER WELD JOINTS AND UP TO BACK OF THERMISTOR BEAD, FOR STRAIN RELIEF AND ELECTRICAL INSULATION.

FOR INSERTION INTO METAL HOUSINGS OR TUBINGS WITH CLOSE TOLERANCES. BEAD EXPOSED AS MUCH AS POSSIBLE FOR FASTER RESPONSE.

MAXIMUM CONTINUOUS OPERATING TEMPERATURE 175° C.



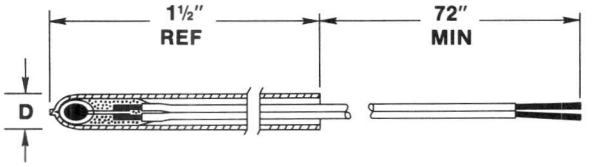
TYPE C INSULATION

AB6C8 -

THERMISTOR WELDED TO 38 GA., NICKEL ALLOY 200, BIFILAR, HEAVY ISOMID INSULATED EXTENSION LEADS, 6½ FT. ± ½ FT. LONG. MULTIPLE CONFORMAL DIP COATS OF LIQUID EPOXY RESIN FOR COMPLETE INSULATION WHEN IMMERSED IN FLUIDS.

FOR USE WHERE FASTEST RESPONSE TIMES ARE REQUIRED AND ASSEMBLY WILL BE FULLY IMMERSED IN CONDUCTIVE FLUIDS.

MAXIMUM CONTINUOUS OPERATING TEMPERATURE 105° C.



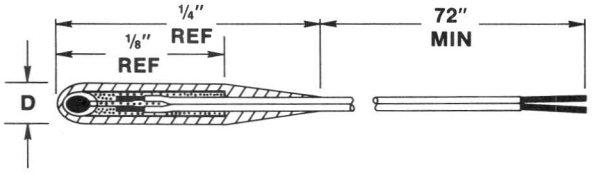
TYPE D INSULATION

AB6D2 -

THERMISTOR WELDED TO 38 GA., NICKEL ALLOY 200, BIFILAR, HEAVY ISOMID EXTENSION LEADS, 6½ FT., ± ½ FT. LONG. SMALL WEB OF EPOXY PAINTED OVER WELD JOINTS FOR ELECTRICAL ISOLATION AND STRAIN RELIEF, HEAT SEALED MYLAR SHEATH OVER BEAD.

FOR FAST RESPONSE TIMES, LIMITED DEPTH OF IMMERSION, AND BEST LONG TERM IMMERSION QUALITIES.

MAXIMUM CONTINUOUS OPERATING TEMPERATURE 125° C.



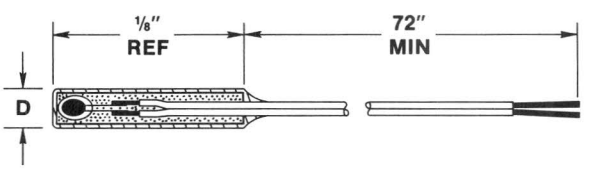
TYPE E INSULATION

AB6E3 -

THERMISTOR WELDED TO 38 GA., NICKEL ALLOY 200, BIFILAR, HEAVY ISOMID INSULATED EXTENSION LEADS, 6½ FT. ± ½ FT. LONG. POLIMIDE SLEEVE IS EPOXIED OVER WELDS FOR STRAIN RELIEF AND ELECTRICAL INSULATION, MULTIPLE CONFORMAL DIP COATINGS OF FORMVAR ENAMEL FOR COMPLETE IMMERSIBILITY IN CONDUCTIVE FLUIDS.

FOR USE IN APPLICATIONS WHERE FAST RESPONSE, GOOD STRAIN RELIEF AND FULL IMMERSION IS REQUIRED.

MAXIMUM CONTINUOUS OPERATING TEMPERATURE 105° C.



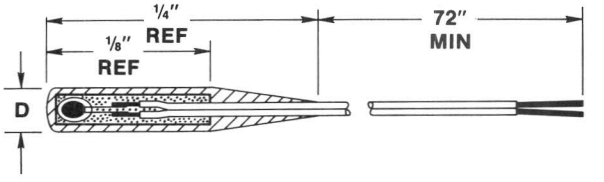
TYPE E INSULATION

AB6E5 -

THERMISTOR BEAD WELDED TO 38 GA., NICKEL ALLOY 200, BIFILAR, HEAVY ISOMID INSULATED EXTENSION LEADS, 6½ FT. ± ½ FT. LONG. POLYIMIDE SLEEVE IS EPOXIED OVER BEAD AND WELD JOINTS FOR STRAIN RELIEF AND INSULATION. LIQUID EPOXY RESIN CONFORMAL DIP COAT IS APPLIED FOR MOISTURE SEALING.

FOR USE WHERE ASSEMBLY WILL BE SUBJECTED TO LIMITED FLUID IMMERSIONS AND WHERE MAXIMUM STRAIN RELIEF IS ALSO REQUIRED WITH MINIMUM O.D.

MAXIMUM CONTINUOUS OPERATING TEMPERATURE 105° C.



TYPE E INSULATION

AB6E8 -

THERMISTOR WELDED TO 38 GA., NICKEL ALLOY 200, BIFILAR, HEAVY ISOMID INSULATED EXTENSION LEADS, 6½ FT. ± ½ FT. LONG. POLYIMIDE SLEEVE IS EPOXIED OVER WELDS AND THERMISTOR FOR STRAIN RELIEF AND ELECTRICAL INSULATION, MULTIPLE CONFORMAL DIP COATINGS OF LIQUID EPOXY RESIN FOR COMPLETE IMMERSIBILITY IN CONDUCTIVE FLUIDS.

FOR USE IN APPLICATIONS WHERE SUPERIOR STRAIN RELIEF AND FULL IMMERSION IS REQUIRED.

MAXIMUM CONTINUOUS OPERATING TEMPERATURE 105° C.

ORDERING INFORMATION:

1) Select the appropriate thermistor bead or small probe from one of the thermistor series shown in Table I. Refer to the appropriate catalog page for electrical and mechanical properties of the thermistor selected and specific ordering information for that thermistor.

2) Select one of the assembly styles shown and use the assembly prefix listed for that style followed by the thermistor part number.
example: AB6A8 - BR16KA103N
This assembly uses a .016" nominal diameter, ruggedized Thermobead (series BR16, page B7) with adjacent cut leads, 10 K ohms ± 25% at 25° C nominal resistance, welded to standard 6½ ± ½ foot long, 38 gauge, nickel alloy 200, bifilar, heavy isomid insulated extensions leads with epoxy resin web between the welded joints for strain relief.

SERIES AB6 - THERMOBEAD AND THERMOPROBE ASSEMBLIES.

TABLE I

STANDARD SIZES OF SERIES AB6 THERMISTOR ASSEMBLIES

THERMISTOR SERIES	CATALOG PAGE	MAXIMUM THERMISTOR DIAMETER	SMALLEST HOLE DIAMETER "D" INTO WHICH ASSEMBLY MAY BE INSERTED							
			A8	B2	B4	C8	D2	E3	E5	E8
B05	B-2	.0065	.013	.016	.014	.021	.033	.020	.019	.022
B07	B-2	.0085	.013	.016	.014	.021	.033	.020	.019	.022
B10	B-4	.0115	.013	.018	.014	.021	.033	.020	.022	.024
B14	B-4	.016	.016	.021	.016	.024	.036	.022	.025	.027
B35	B-6	.042	.042	.050	.042	.050	.062	.048	.054	.056
B43	B-6	.050	.050	.056	.050	.058	.070	.056	.060	.062
BR11	B-8	.012	.014	.018	.014	.022	.034	.020	.022	.024
BR14	B-10	.016	.016	.021	.016	.024	.036	.022	.025	.027
BR16	B-10	.017	.017	.022	.017	.025	.037	.023	.026	.028
BR23	B-12	.025	.025	.032	.025	.033	.045	.031	.036	.038
BR32	B-14	.033	.033	.040	.033	.041	.053	.039	.044	.046
BR42	B-16	.046	.046	.053	.046	.054	.066	.052	.057	.059
BR55	B-18	.060	.060	.070	.060	.068	.080	.066	.074	.076
P20	C-1	.020	.020	.026	.020	.028	.040	.026	.030	.032
P25	C-1	.025	.025	.031	.025	.033	.045	.031	.035	.037
P30	C-3	.030	.030	.036	.030	.038	.050	.036	.040	.042

NOTE: ALL DIMENSIONS ARE IN INCHES.

SPECIAL ORDERING INFORMATION:

The assembly styles shown represent the most standard selections of the many combinations of thermistors and materials which THM manufactures. These selected styles are suitable for many applications, however, there are always special requirements which need to be satisfied for some applications. A partial listing of alternate materials and options is given below to assist the designer for applications in which the standard units shown are not suitable. If assistance is required in the selection of materials or design of the assembly, please contact our Applications Engineering Department and detail the exact requirements or specifications desired.

OPTIONS: The standard units may be modified to suit the users particular needs by specifying any of the following options.

- Non-standard resistance values
- Reference temperature other than 25° C
- Non-standard tolerances (at one or more temperatures)
- Longer or shorter extension leads
- Special mountings or enclosures
- Special wire terminations and mountings
- Calibration - specify calibration schedule see pg. (A-0 and temperatures.
- Interchangeable pairs, sets; curve matching - specify temperatues and tolerances.

ALTERNATE MATERIALS SELECTION: The alternate materials listed are available for series AB6 thermistor assembly orders. Other materials may be available to the designer or user upon special order. Please allow additional time for the completion of special assembly orders.

TYPE A INSULATIONS - A web of insulating material is put over the weld joints for strain relief. Available insulating materials with maximum temperature ratings;

VINYL	(60° C)
POLYURETHANE	(105° C)
FORMVAR ENAMEL	(105° C)
SILICONE RUBBER	(260° C)
EPOXIES	(FROM 105° C to 260° C) - specify max temperature required.

TYPE B INSULATIONS - A polyimide sleeve is epoxied over the weld joints for improved strain relief and electrical insulation. The bead may be covered for maximum strain relief or exposed for faster response. Epoxies are generally used to fill the polyimide sleeve and have temperature ratings from 105° C to 260° C.

TYPE C INSULATIONS - Multiple conformal dip coats over the thermistor and welds are used in order to provide fully immersible assemblies. Any of the Type A insulating materials may be used for the conformal dip coatings depending upon the application or environment.

TYPE D INSULATIONS - A thermoplastic tubing is heat sealed over the bead or probe thermistor. A small amount of insulating material is applied over the weld joints for electrical isolation. The assembly is not fully immersible over the back end of the tubing. Available heat sealed tubing materials with maximum temperature ratings:

POLYETHYLENE	(80° C)
MYLAR	(125° C)

TYPE E INSULATIONS - A polyimide sleeve is epoxied over the weld joints (as in the type B insulations) and then multiple conformal dip coatings are applied (as in the type C insulations) for fully immersible assemblies. The same insulating material options are available.

INSULATED EXTENSION LEADS - The standard insulted extension lead sub assembly would have 38 gauge (.004" dia.), nickel alloy 200, bifilar, heavy isomid insulation over conductors and a length of 6½ ± ½ feet. The various options available are listed below. Unless otherwise specified parameters listed in boldface type are used. Other options, including any specified by the customer, are available upon special order.

WIRE GAUGES

#38 GA (.004"), #40GA (.0031")

CONDUCTORS

NICKEL ALLOY 200, nickel alloy 270

INSULATION

HEAVY ISOMID for use to 180° C, excellent abrasion resistance, our standard coating.

POLYURETHANE - for use to 105° C, easily stripped, exellent solderability.

POLYIMIDE - for use to 230° C, excellent thermal and dielectric properties, (not recommended for water and certain othe conductive fluids)

CONSTRUCTION

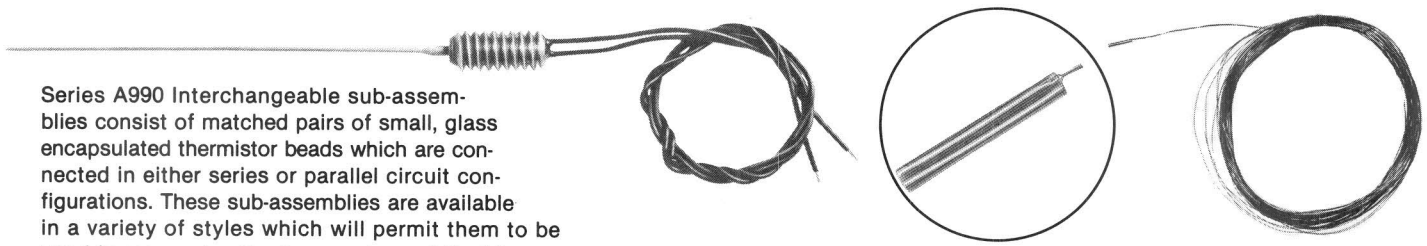
BIFILAR parallel conductors, our standard

SINGLE - individually insulated lead wires
TWISTED PAIR - 0.1 inch lay typical

LENGTH

6½ ± ½ feet is standard, specify other lengths as desired. All lengths over one foot are supplied on a plastic bobbin with the wires wrapped so that the thermistor end is removed last.

SERIES A990



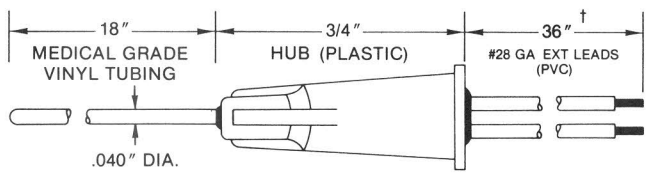
Series A990 Interchangeable sub-assemblies consist of matched pairs of small, glass encapsulated thermistor beads which are connected in either series or parallel circuit configurations. These sub-assemblies are available in a variety of styles which will permit them to be used in measuring the temperature of liquids or solids or to be encapsulated into larger housings such as hypodermic needles or closed end sheaths.

The sub-assemblies provide interchangeable resistance-temperature characteristics in extremely small, fast response packages which are easy to handle. The units shown are available from stock or with fast delivery. Resistance, tolerances and temperature ranges other than those which are indicated may be available upon special order. Other assembly configurations may be available upon special order. Please consult factory for any special requests or modifications.

Maximum Operating or Storage Temperature for Optimum Stability is 105°C.

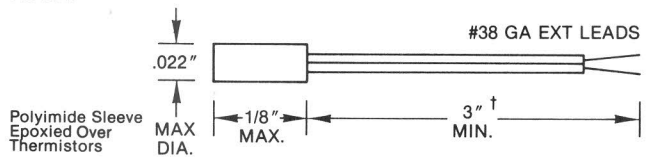
Series A990 Interchangeable Sub-Assemblies

A990P********



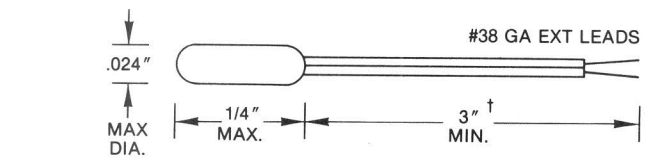
	STILL AIR	WATER PLUNGE
T.C.	6.0 SEC.	.3 SEC.
D.C.	.6 mW/°C	STILL WATER 1.2 mW/°C

A990B********



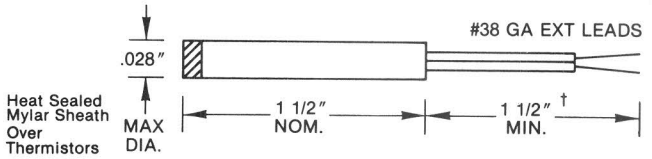
	STILL AIR	WATER PLUNGE
T.C.	1.5 SEC.	.150 SEC.
D.C.	.36 mW/°C	STILL WATER 1.0 mW/°C

A990C********



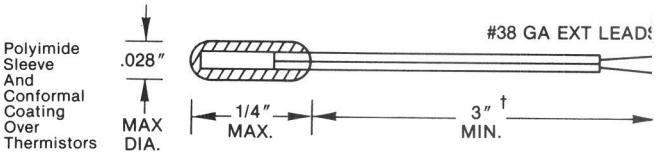
	STILL AIR	WATER PLUNGE
T.C.	1.5 SEC.	.150 SEC.
D.C.	.40 mW/°C	STILL WATER 1.1 mW/°C

A990D********



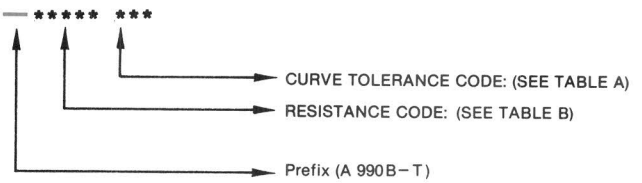
	STILL AIR	WATER PLUNGE
T.C.	2.0 SEC.	.200 SEC.
D.C.	.50 mW/°C	STILL WATER 1.2 mW/°C

A990E********



	STILL AIR	WATER PLUNGE
T.C.	2.0 SEC.	.200 SEC.
D.C.	.40 mW/°C	STILL WATER 1.1 mW/°C

ORDERING INFORMATION



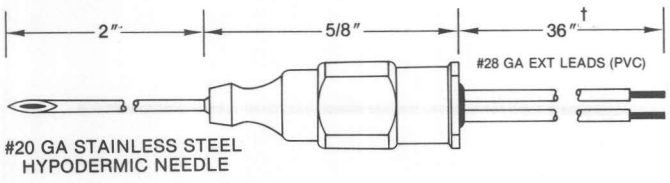
†LONGER LEADS ARE AVAILABLE ON REQUEST

T.C. = THERMAL TIME CONSTANT
D.C. = DISSIPATION CONSTANT

808 U.S. HIGHWAY #1•EDISON, NEW JERSEY 08817-4695•(201) 287-2870•TELEX 844-387

A990M ********

HYPODERMIC NEEDLE ASSEMBLY

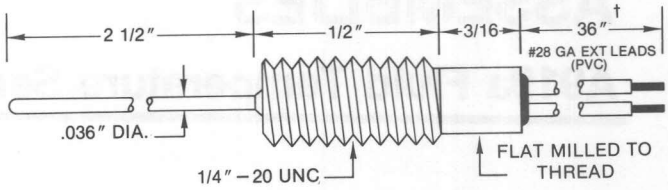


		STILL AIR	WATER PLUNGE
T.C.		15 SEC.	.250 SEC.
D.C.	STILL AIR .80 mW/°C	STILL WATER 1.7 mW/°C	

T.C. = THERMAL TIME CONSTANT
D.C. = DISSIPATION CONSTANT

A990T ********

STAINLESS STEEL SHEATH WITH THREADED HUB



		STILL AIR	WATER PLUNGE
T.C.		16 SEC.	.300 SEC.
D.C.	STILL AIR .80 mW/°C	STILL WATER 1.8 mW/°C	

†LONGER LEADS ARE AVAILABLE ON REQUEST

TABLE A: CURVE TOLERANCES

	TEMPERATURE TOLERANCE IN °C (±)			
TOL. CODE	0°C-25°C	25°C-50°C	50°C-70°C	70°C-105°C
Sx1	.1	.05	.1	.2
Sx2	.1	.1	.1	.2
Sx3	.2	.1	.2	.3
Sx4	.2	.2	.2	.3

TABLE B: RESISTANCE VS. TEMPERATURE CHARACTERISTICS

TEMP (°C)	RESISTANCE CODE (DATA IN OHMS)					
	UN 103	UT 103	UN 223	UT 223	UN 443	UT 443
0	14129.9	56519.5	31452.1	125808	64394.4	257577.5
5	11335.1	45340.5	25168.0	100672	51167.4	204669.5
10	9152.8	36611.2	20273.6	81094.6	40931.5	163726.2
15	7437.4	29749.5	16435.7	65742.7	32956.3	131825.2
20	6080.3	24321.1	13406.3	53625.1	26701.3	106805.3
25	5000.0	20000.0	11000 0	44000.0	21764.2	87056.8
30	4134.9	16539.7	9077.0	36307.9	17843.2	71372.8
35	3438.1	13752.5	7531.1	30124.5	14710.6	58842.5
40	2873.8	11495.1	6281.4	25125.7	12193.5	48774.1
45	2414.2	9656.7	5265.6	21062.5	10159.7	40638.8
50	2038.0	8151.9	4435.6	17742.3	8507.6	34030.3
55	1728.4	6913.8	3753.9	15015.5	7154.4	28617.7
60	1472.6	5890.2	3191.3	12765.2	6043.0	24171.9
65	1260.0	5040.0	2724.8	10899.2	5126.1	20504.4
70	1082.7	4330.6	2336.2	9344.9	4366.4	17465.8
75	934.02	3736.1	2011.1	8044.5	3734.4	14937.8
80	808.93	3235.7	1738.0	6952.0	3206.5	12825.9
85	703.23	2812.9	1507.6	6030.3	2763.7	11054.7
90	613.55	2454.2	1312.4	5249.6	2390.8	9563.4
95	537.18	2148.7	1146.5	4586.0	2075.7	8303.0
100	471.90	1887.6	1004.9	4019.6	1808.5	7233.9
105	415.90	1663.6	883.67	3534.7	1580.9	6323.7

APPLICATIONS:

A990B — For insertion into metal housing or close tolerance openings.

A990C — Fully immersible sub-assembly for use in conductive fluids.

A990D — Limited depth immersion or surface contact.

A990E — Fully immersible sub-assembly with additional mechanical strain relief.

A990M — Sub-assembly encapsulated into sharpened hypodermic needle with 3 foot extension leads of #28 GA PVC wire. For various laboratory temperature measurements.

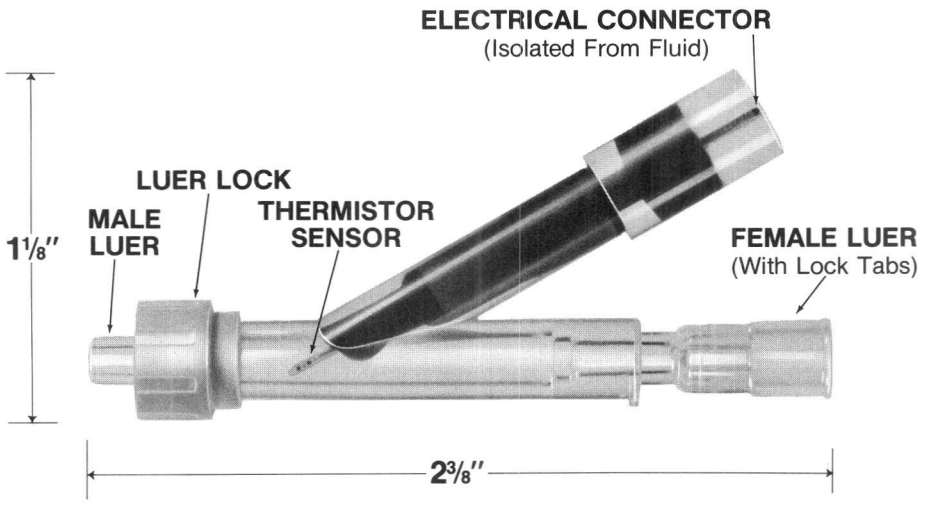
A990P — Standard sub-assembly encapsulated into vinyl catheter tubing with #28 GA PVC wire extension leads.

A990T — Sub-assembly encapsulated into closed end stainless steel sheath with threaded hub. For various commercial applications or severe environments.

ASSEMBLIES

A919a Fluid Temperature Sensor

FAST RESPONSE FLUID TEMPERATURE SENSOR for Laboratory, Medical Research & Industrial Use



Thermometrics, Inc., is the leading manufacturer of thermodilution thermistors and thermistor assemblies; and so is eminently qualified to introduce this major innovation in the temperature measurement of fluid streams:

the A919a
"Y" FLUID TEMPERATURE SENSOR

Ultrastable and very sensitive to even small temperature changes, the A919a enables the user to obtain rapid, accurate and repeatable temperature measurements in moving or static streams without contaminating the stream or interfering with the flow. The standard sensor is suitable for use in the laboratory, test situations and disposable medical research products. The ruggedized version, the A919b is well suited for industrial applications. Refer to Bulletin A919b for further details about the ruggedized A919b.

Design:

Unitherm Thermistor Sensors enclosed in heat sealed plastic are encapsulated into a plastic luer to form a leakproof unit composed of inert, non-contaminating materials which are compatible with approved FDA materials. An electrical connector is molded in for convenient electrical hook-up on laboratory bridges or voltage divider circuits (depending on application). The sensor may be ethelyne oxide sterilized. The A919a "Y" Fluid Temperature Sensor is a small, high volume, low cost unit. The size is approximately 2⅜ inches long and 1⅛ inch high. When used in an intravenous or similiar line it can be installed as rapidly as a hypodermic needle.

THERMOMETRICS INC.

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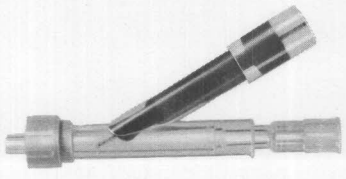
Temperature versus Thermistor Resistance for Standard A919 Sensors

Deg. C.	Resistance in Ohms	Deg. C.	Resistance in Ohms	Deg. C.	Resistance in Ohms	Deg. C.	Resistance in Ohms
0.00	56341.02	12.50	32931.96	25.00	20000.00	37.50	12579.79
0.50	55100.98	13.00	32258.53	25.50	19619.70	38.00	12357.11
1.00	53891.82	13.50	31600.79	26.00	19247.70	38.50	12139.00
1.50	52712.66	14.00	30958.34	26.50	18883.81	39.00	11925.35
2.00	51562.71	14.50	30330.79	27.00	18527.82	39.50	11716.05
2.50	50441.16	15.00	29717.76	27.50	18179.56	40.00	11511.00
3.00	49347.23	15.50	29118.86	28.00	17838.82	40.50	11310.12
3.50	48280.17	16.00	28533.75	28.50	17505.43	41.00	11113.29
4.00	47239.27	16.50	27962.07	29.00	17179.21	41.50	10920.44
4.50	46223.79	17.00	27403.47	29.50	16859.98	42.00	10731.47
5.00	45233.07	17.50	26857.63	30.00	16547.59	42.50	10546.29
5.50	44266.43	18.00	26324.21	30.50	16241.87	43.00	10364.82
6.00	43323.24	18.50	25802.91	31.00	15942.65	43.50	10186.97
6.50	42402.85	19.00	25293.41	31.50	15649.79	44.00	10012.67
7.00	41504.66	19.50	24795.43	32.00	15363.13	44.50	9841.83
7.50	40628.07	20.00	24308.67	32.50	15082.52	45.00	9674.38
8.00	39772.52	20.50	23832.85	33.00	14807.83	45.50	9510.24
8.50	38937.45	21.00	23367.70	33.50	14538.91	46.00	9349.34
9.00	38122.30	21.50	22912.94	34.00	14275.62	46.50	9191.60
9.50	37326.56	22.00	22468.33	34.50	14017.84	47.00	9036.95
10.00	36549.71	22.50	22033.61	35.00	13765.44	47.50	8885.34
10.50	35791.26	23.00	21608.53	35.50	13518.29	48.00	8736.68
11.00	35050.72	23.50	21192.86	36.00	13276.27	48.50	8590.92
11.50	34327.63	24.00	20786.37	36.50	13039.25	49.00	8447.99
12.00	33621.52	24.50	20388.82	37.00	12807.13	49.50	8307.83
						50.00	8170.38

Interchangeability ± 0.25°C from 0°C to 30°C

Options: the following modifications to the standard unit are possible, and should be discussed with our Applications Engineering Staff for price and availability.

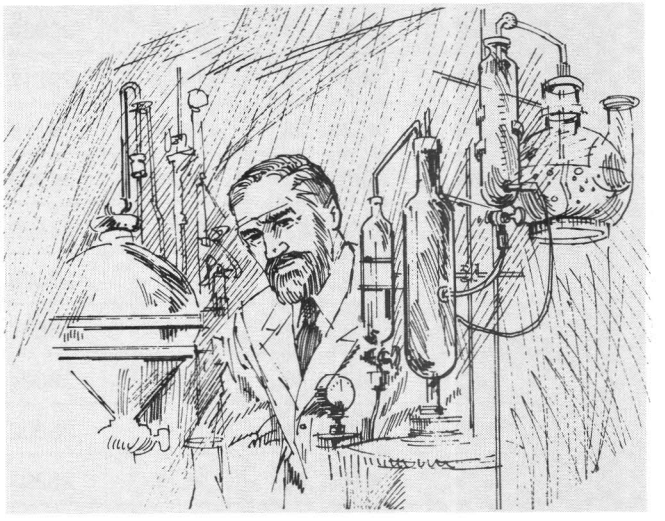
- Non-standard resistance values
- Non-standard tolerances (at one or more temperatures)
- Non-standard time constants
- Ruggedized version

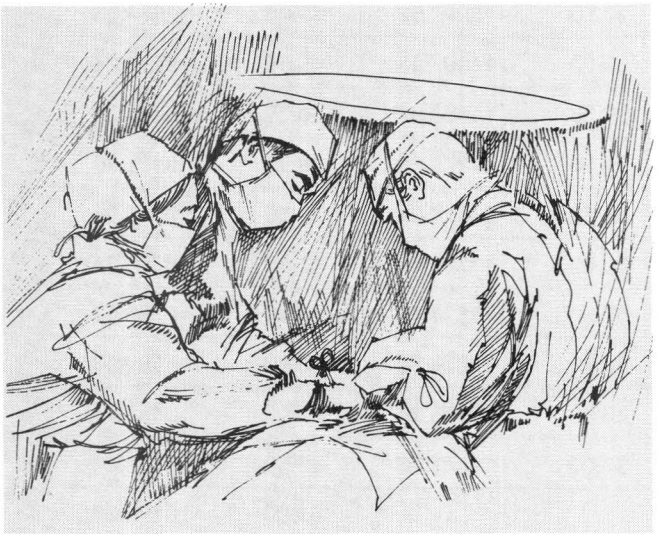


BIOMEDICAL THERMISTOR ASSEMBLIES

INTERCHANGEABLE • FAST RESPONSE • HIGH STABILITY

Our new Biomedical Chip Thermistor assemblies are designed for use in applications involving both intermittent and continuous patient temperature monitoring. Repeatability and fast response are essential not only for the intermittent temperature requirements associated with oral and rectal fever measurements, but also with the continuous monitoring often necessary during induced-hypothermia and general anethesia, or when employed in the care of infants and premature babies. Intensive care units along with recovery rooms have also adopted patient temperature as part of their vital sign monitoring procedures. Temperature monitoring for skin surface, tympanic, esophageal, foley catheters and bio-feedback applications has also improved due to the high stability and tight interchangeable tolerances designed into each Thermometrics' Biomedical assembly.





A complete line of standard sub-assemblies is available, as shown in Figure 1; however, continuous research and development efforts within Thermometrics has resulted not only in these field proven designs, but in the development of our new Unitherm Thermochip Thermistor designed exclusively for biomedical applications in the range of 0° C to 50° C. Although low in cost, these highly stable, precision thermochips provide the reliability, tight interchangeable tolerances, geometries, and fast response times required. To keep pace with this ever-improving biomedical market, our material system and processing parameters are closely monitored and improved to continually provide you with reliable, quality products. In addition, should you require it, Thermometrics employs a complete staff of experienced full-time applications engineers who welcome your inquiries, whether it's for assistance, or to help with your design requirements concerning new and existing applications.

THERMOMETRICS INC.

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MA SERIES

MA100

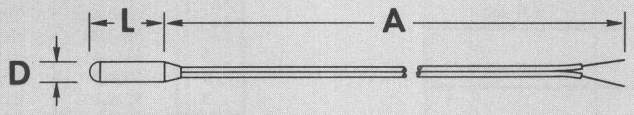


FIGURE 1A

Designed for use in catheter assemblies these sensors are available with nominal resistance values of 2252, 3000, 5000, and 10,000 ohms at 25° C. Close monitoring of manufacturing processes allow us to maintain tight interchangeability tolerances with volume production. Typical design parameters are represented in Table 1.

NOTE: .030″ (10 K ohm only) and .050″ diameters available with kapton sleeve only.
.070″ diameter normally supplied with molded plastic tip.

MA200

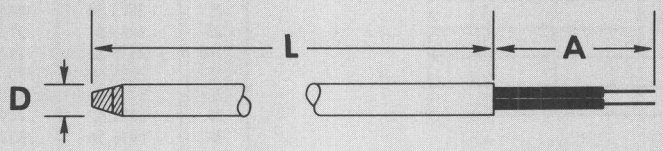


FIGURE 1B

Intermittent body temperature measurements are common practice in all phases of patient care. This assembly is idealy suited for the disposable cover oral and rectal fever thermometers in use today. It features rugged construction with tip sensitive shaft assemblies exhibiting resistance values of 2252, 3000, 5000, and 10,000 ohms at 25° C.
Refer to Table 1 for typical design parameters.

MA300

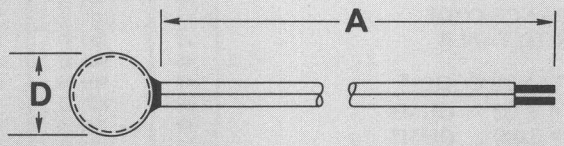


FIGURE 1C

Routine continuous patient temperature monitoring is now feasible by using the convenience of the patient's skin site as an indicator of body temperature. The stainless steel housing used is suitable for both reusable and disposable applications, while maintaining maximum patient comfort. Nominal resistance values of 2252, 3000, 5000, and 10,000 ohms at 25° C are available.
Refer to Table 1 for typical design parameters.

TABLE 1

ASSEMBLY TYPE	MA100	MA200	MA300
STANDARD DIAMETERS D	.030″ .050″ .070″	.156″	.375″
BODY LENGTH L	3/8″	3.75″	N/A
LEAD LENGTH A	24″	2″	24″
TOLERANCE	SEE TABLE	SEE TABLE	SEE TABLE
WIRE GAUGE	30, 32, 38 AWG	30 AWG	30 AWG
STANDARD WIRE INSULATION	●HEAVY ISOMID ●MEDICAL GRADE PVC ●POLYURETHANE WITH NYLON OVERCOAT	TEFLON	●MEDICAL GRADE PVC ●TEFLON
BODY MATERIAL	MOLDED PLASTIC OR KAPTON SLEEVE	LEXAN SHAFT ALUMINUM TIP	STAINLESS STEEL
NOMINAL R VALUES @25° C	2252, 3000, 5000, 10,000 OHMS		

THERMAL RESPONSE TIME (63% RESPONSE)

SERIES	STILL AIR	STILL WATER*
MA100 CATHETER ASSEMBLY	15 sec.	2.0 sec.
MA200 ORAL-RECTAL ASSEMBLY	35 sec..	0.6 sec.
MA300 SKIN SURFACE ASSEMBLY	45 sec.	2.0 sec.

*RESPONSE TIME PROVIDED IS FOR ASSEMBLY PLUNGED FROM 25°C AIR to 5°C STILL WATER.

TOLERANCE CODE AND TEMPERATURE RANGE

TEMPERATURE RANGE °C	TOLERANCE CODE A ±°C	B ±°C	C ±°C
0-20	.15	.2	.25
20-35	.1	.15	.2
35-39	.05	.1	.15
39-42	.075	.15	.2
42-45	.1	.15	.2
45-50	.15	.2	.25

MAXIMUM TEMPERATURE

OUR BIOMEDICAL SERIES THERMISTOR CHIPS AND SUB ASSEMBLIES ARE DESIGNED TO BE INTERCHANGEABLE OVER A 0°C to 50°C RANGE. BEST OVERALL STABILITY IS MAINTAINED WHEN EXPOSURE AND STORAGE TEMPERATURES REMAIN BELOW 70°C.

ORDERING INFORMATION

MA XXXXX - XXX - X

TOLERANCE CODE: REFER TO TABLE

RESISTANCE CODE: *

232 = 2,252 OHMS
302 = 3,000 OHMS
502 = 5,000 OHMS
103 = 10,000 OHMS
103(Y) = 10,000 OHMS

*Refer to Resistance vs. Temperature Table

STANDARD ASSEMBLIES

100FA - SERIES 100, .070″ DIAMETER MOLDED PLASTIC TIP, 30 GAUGE PVC INSULATED RIBBON CABLE.

100FD - SERIES 100, .070″ DIAMETER MOLDED PLASTIC TIP, 32 GAUGE BIFILAR HEAVY ISOMID INSULATION.

100DD - SERIES 100, .050″ DIAMETER KAPTON SLEEVE WITH 32 GAUGE BIFILAR HEAVY ISOMID INSULATION.

100BF - SERIES 100, .030″ DIAMETER KAPTON SLEEVE WITH 38 GAUGE BIFILAR HEAVY ISOMID INSULATION.

200LC - SERIES 200, .156″ DIAMETER ALUMINUM TIP, 30 GAUGE TEFLON LEADS.

300TA - SERIES 300, .375″ DIAMETER STAINLES STEEL CUP, 30 GAUGE PVC INSULATED RIBBON CABLE.

300TB - SERIES 300, .375″ DIAMETER STAINLESS STEEL CUP, 30 GAUGE TEFLON INSULATED RIBBON CABLE.

OPTIONS

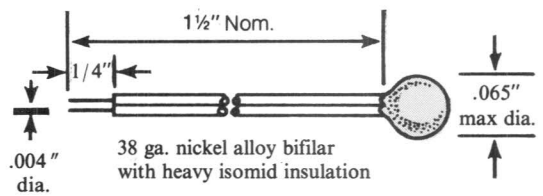
- CALIBRATION - SPECIFY ACCURACY AND TEMPERATURE
- NON-STANDARD RESISTANCE VALUES
- EXTENSION LEADS, SPECIFY LENGTH, MATERIAL, ETC.
- SPECIAL MOUNTINGS OR ENCLOSURES
- LEAD TERMINATION - SPECIFY TYPE

RESISTANCE VS. TEMPERATURE

temp °C	2252Ω	3KΩ	5KΩ	10KΩ	103(Y)Ω
0	7352.90	9795.16	16325.3	32650.5	29491.24
1	6988.42	9309.62	15516.0	31032.1	28157.49
2	6643.38	8849.98	14750.0	29499.9	26891.19
3	6317.41	8415.73	14026.2	28052.4	25688.61
4	6009.39	8005.39	13342.3	26684.6	24546.22
5	5718.10	7617.37	12695.6	25391.2	23460.72
6	5442.68	7250.46	12084.1	24168.2	22428.99
7	5182.12	6903.35	11505.6	23011.2	21448.12
8	4935.54	6574.88	10958.1	21916.3	20515.34
9	4702.12	6263.93	10439.9	20879.8	19628.07
10	4481.09	5969.48	9949.14	19898.3	18783.87
11	4271.72	5690.57	9484.28	18968.6	17980.43
12	4073.33	5426.28	9043.80	18087.6	17215.58
13	3885.28	5175.78	8626.30	17252.6	16487.30
14	3706.99	4938.27	8230.45	16460.9	15793.65
15	3537.90	4713.01	7855.01	15710.0	15132.82
16	3377.47	4499.30	7498.83	14997.7	14503.11
17	3225.23	4296.48	7160.80	14321.6	13902.89
18	3080.70	4103.95	6839.92	13679.8	13330.64
19	2943.46	3921.13	6535.22	13070.4	12784.92
20	2813.11	3747.48	6245.80	12491.6	12264.39
21	2689.26	3582.49	5970.82	11941.6	11767.75
22	2571.54	3425.68	5709.47	11418.9	11293.80
23	2459.64	3276.61	5461.01	10922.0	10841.39
24	2353.22	3134.84	5224.74	10449.5	10409.44
25	2252.00	3000.00	5000.00	10000.0	10000.00
26	2155.69	2871.70	4786.16	9572.32	9602.89
27	2064.02	2749.59	4582.64	9165.29	9226.41
28	1976.76	2633.34	4388.89	8777.79	8866.62
29	1893.67	2522.10	4204.34	8408.68	8522.70
30	1814.51	2417.19	4028.66	8057.31	8193.89
31	1739.09	2316.73	3861.22	7722.43	7879.43
32	1667.22	2220.99	3701.65	7403.29	7578.65
33	1598.51	2129.52	3549.20	7098.42	7290.88
34	1533.20	2042.50	3404.18	6808.36	7015.50
35	1470.89	1959.39	3265.65	6531.31	6751.92
36	1411.58	1880.47	3134.12	6265.75	6499.57
37	1354.91	1804.94	3008.23	6016.47	6257.93
38	1300.77	1732.82	2888.03	5776.05	6026.49
39	1249.08	1663.96	2773.26	5546.53	3804.78
40	1199.72	1598.20	2663.67	5327.34	5592.33
41	1152.57	1535.39	2558.99	5117.97	5388.73
42	1107.52	1475.38	2458.97	4917.94	5193.56
43	1064.47	1418.03	2363.39	4726.77	5006.43
44	1023.30	1363.17	2271.95	4543.91	4826.98
45	983.97	1310.80	2184.66	4369.33	4654.86
46	946.02	1260.25	2100.92	4200.84	4489.73
47	909.99	1212.24	2020.40	4040.81	5331.28
48	875.92	1166.85	1944.76	3889.51	4179.20
49	842.96	1122.95	1871.59	3743.17	4033.22
50	811.42	1080.93	1801.55	3603.10	3893.05

MC SERIES

10KΩ EPOXY COATED MINIATURE THERMOCHIP AVAILABLE FOR DIRECT OEM APPLICATIONS



MC65F

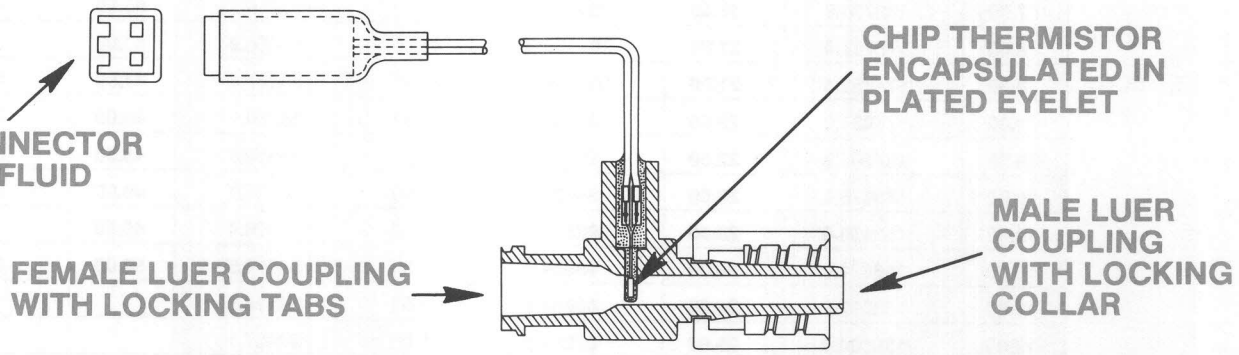
TOLERANCE CODE AND TEMPERATURE RANGE REFER TO TABLE

RESISTANCE CODE:
103 = 10,000 OHMS
103(Y) = 10,000 OHMS

disposable "T" fluid temperature sensor

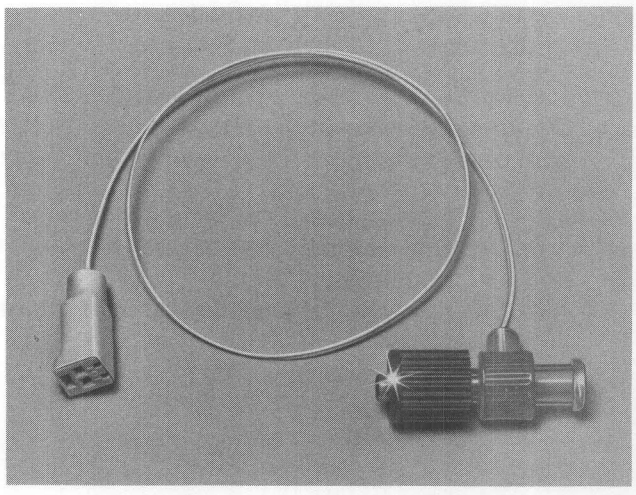
FOR BIOMEDICAL, LABORATORY & INDUSTRIAL USE

SERIES A-954



The "T" fluid temperature sensor is based on the most advanced chip thermistor technology to provide rapid, accurate and repeatable temperature measurements in moving or static streams without contaminating the flow. With ± 0.25° C tolerance between 0° C and 50° C you are assured complete unit to unit interchangeability. Compact yet versatile, with a package size of 1.17" long x .85" high, these units are ideally suited for test situations in the laboratory, disposable medical applications, and many industrial products.

Standard male and female luer couplings with locking tabs and collar allow for quick and easy installation. A convenient electrical connector is provided with 12" of 30GA PVC insulated, bifilar cable. A plated eyelet is used to isolate the thermistor and provide a sealed, non-contaminating medium between the stream and "T" portions of the luer.



THERMOMETRICS INC.
The Source of Thermistor Expertise

808 U.S. HIGHWAY #1 EDISON, NEW JERSEY 08817-4695 (201) 287-2870 TELEX 844-387

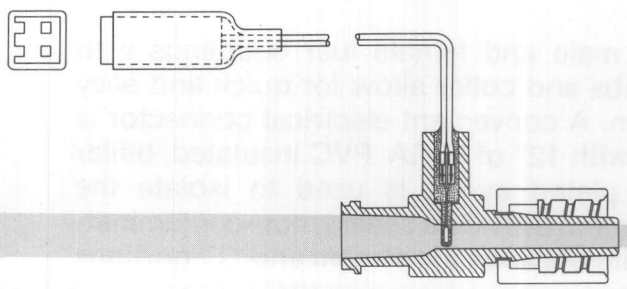
RESISTANCE VS. TEMPERATURE CHARACTERISTICS

TEMP. °C	RESISTANCE IN OHMS	TEMP. °C	RESISTANCE IN OHMS	TEMP. °C	RESISTANCE IN OHMS	TEMP. °C	RESISTANCE IN OHMS
0.00	256949.0	13.00	143654.8	26.00	83620.7	39.00	50504.5
.50	251068.1	13.50	140594.2	26.50	81960.4	39.50	49568.8
1.00	245337.6	14.00	137606.9	27.00	80337.5	40.00	48652.9
1.50	239753.5	14.50	134691.2	27.50	78750.9	40.50	47756.2
2.00	234311.5	15.00	131844.9	28.00	77199.9	41.00	46878.4
2.50	229007.8	15.50	129066.5	28.50	75683.5	41.50	46018.9
3.00	223838.4	16.00	126353.9	29.00	74200.9	42.00	45177.5
3.50	218799.7	16.50	123705.7	29.50	72751.2	42.50	44353.6
4.00	213888.0	17.00	121119.9	30.00	71333.6	43.00	43546.8
4.50	209099.9	17.50	118595.2	30.50	69947.4	43.50	42756.8
5.00	204431.8	18.00	116129.8	31.00	68591.7	44.00	41983.1
5.50	199880.5	18.50	113722.2	31.50	67265.8	44.50	41225.5
6.00	195442.8	19.00	111370.8	32.00	65969.0	45.00	40483.4
6.50	191115.6	19.50	109074.4	32.50	64700.6	45.50	39756.6
7.00	186895.8	20.00	106831.4	33.00	63459.9	46.00	39044.7
7.50	182780.6	20.50	104640.5	33.50	62246.3	46.50	38347.4
8.00	178767.0	21.00	102500.3	34.00	61058.9	47.00	37664.3
8.50	174852.4	21.50	100409.5	34.50	59897.4	47.50	36995.1
9.00	171034.0	22.00	98366.9	35.00	58760.9	48.00	36339.5
9.50	167309.3	22.50	96371.3	35.50	57649.0	48.50	35697.2
10.00	163675.6	23.00	94421.5	36.00	56561.0	49.00	35067.8
10.50	160130.6	23.50	92516.2	36.50	55496.4	49.50	34451.2
11.00	156671.9	24.00	90654.5	37.00	54454.5	50.00	33847.0
11.50	153297.2	24.50	88835.1	37.50	53434.9		
12.00	150004.2	25.00	87057.0	38.00	52437.1		
12.50	146790.8	25.50	85319.2	38.50	51460.5		

INTERCHANGEABILITY ± .25°C FROM 0°C TO 50°C
TIME CONSTANT - .2 SECOND IN LIQUID.

Options: the following modifications to the standard unit are possible, and should be discussed with our Applications Engineering Staff for price and availability.

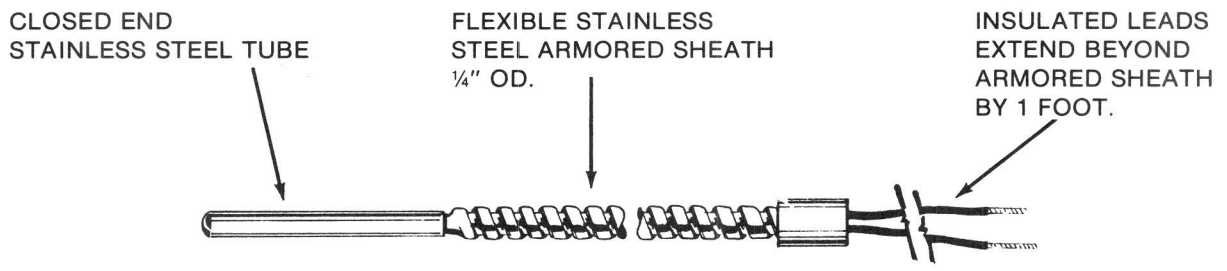
- Non-standard resistance values
- Non-standard tolerances (at one or more temperatures)
- Longer lead lengths
- Non-standard terminations or connector



ASSEMBLIES

SERIES A800 — Armored Sheath Assembly

STYLE:
Series A800 ARMORED SHEATH ASSEMBLIES consist of a thermistor, hermetically sealed in a glass envelope; which has been assembled into a stainless steel housing. An armored sheath protects the extension leads. The assembly offers excellent protection against rough handling, abrasion, corrosive environment and extreme temperature exposure.
Armored sheath assemblies are available with a large variety of thermistor sizes and resistance values. Any of the THERMOPROBES listed on pages C-3 and E-3 may be specified.



OPERATING TEMPERATURE:
Standard units are rated from -40° C to 300° C. Higher temperature units may be obtained on special order.

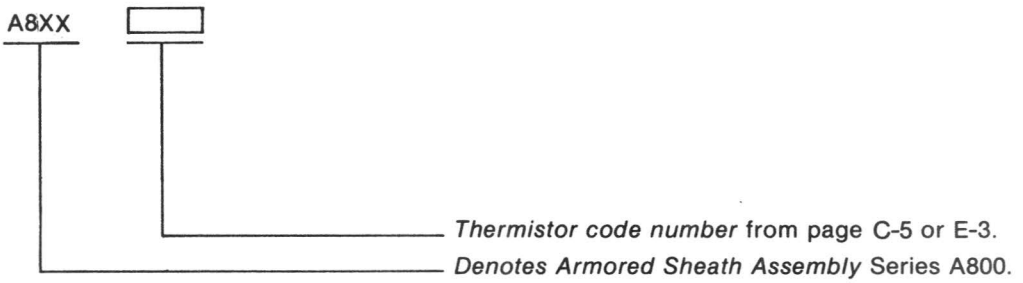
CONSTRUCTION:
The thermistor probe or probes are encapsulated into a stainless steel enclosure with a flexbile, protective armor sheath over the extension leads, and are available with a variety of materials and insulations based upon the specific application. The housing may be a straight tube, as shown in the figure, or may have an adaptor collar or threaded hex body as desired. Please consult the factory for assistance in the selection of construction materials and various options.

SIZE: — specify when ordering
STANDARD TUBE DIAMETERS are 1/8", 3/16", 1/4".
STANDARD TUBE LENGTHS: are 1" to 6" in 1" increments.
STANDARD LEAD LENGTH: The armored sheath lengths are 2' to 25' in 1' increments. The insulated leads extend 1 foot beyond the sheath. Longer lengths are available upon special order.
SHEATH DIAMETER is 1/4".
Specify termintion or connector if any.

APPLICATIONS:
ARMORED SHEATH ASSEMBLIES are used where extreme temperatures and hard service are encountered. The probes may be immersed in any fluid up to 1/4" of the hub on the sheath. The materials are selected for corrosion resistance and designed for long service with high temperature variations. The SERIES A800 units find application for monitoring or controlling temperature of hot corrosive fluids, temperature of air or pastes, process control. The protected leads offer resistance against moving parts and other rubbing actions.

The same thermistor characteristics that apply to the selected thermistor: resistance value, resistance ratio, stability; are unaltered in the assembly. Response time is slowed by the assembly and should be considered in the design.

ORDERING INFORMATION



For example:
An assembly with a 1/4" diameter x 4 inch long stainless steel tube, a 4 foot long armored, flexible sheath, with one foot extended leads and a P100DB103M thermistor probe .100" diameter x 1/2" long, (10K ohm ± 20% tolerance) is $57.00/each in quantities of 1 to 9 pieces. This assembly may be ordered as part number A802-P100DB103M. Another example would be an assembly with a 3/16" O.D. x 1-1/4" long closed end stainless steel tubing, with a 1/8-27 NPT body, a 3 foot armored flexible sheath, with one foot extended leads and a P60DB104M thermistor probe (.060" diameter x 1/2" long, 100K ohm ± 20% tolerance) is $66.00/each in quantities of 1 to 9 pieces. This assembly may be ordered as part number A801-P60DB104M.

OPTIONS:

The standard units may be modified to suit the users particular needs by specifying any of the following options:

THERMISTORS:

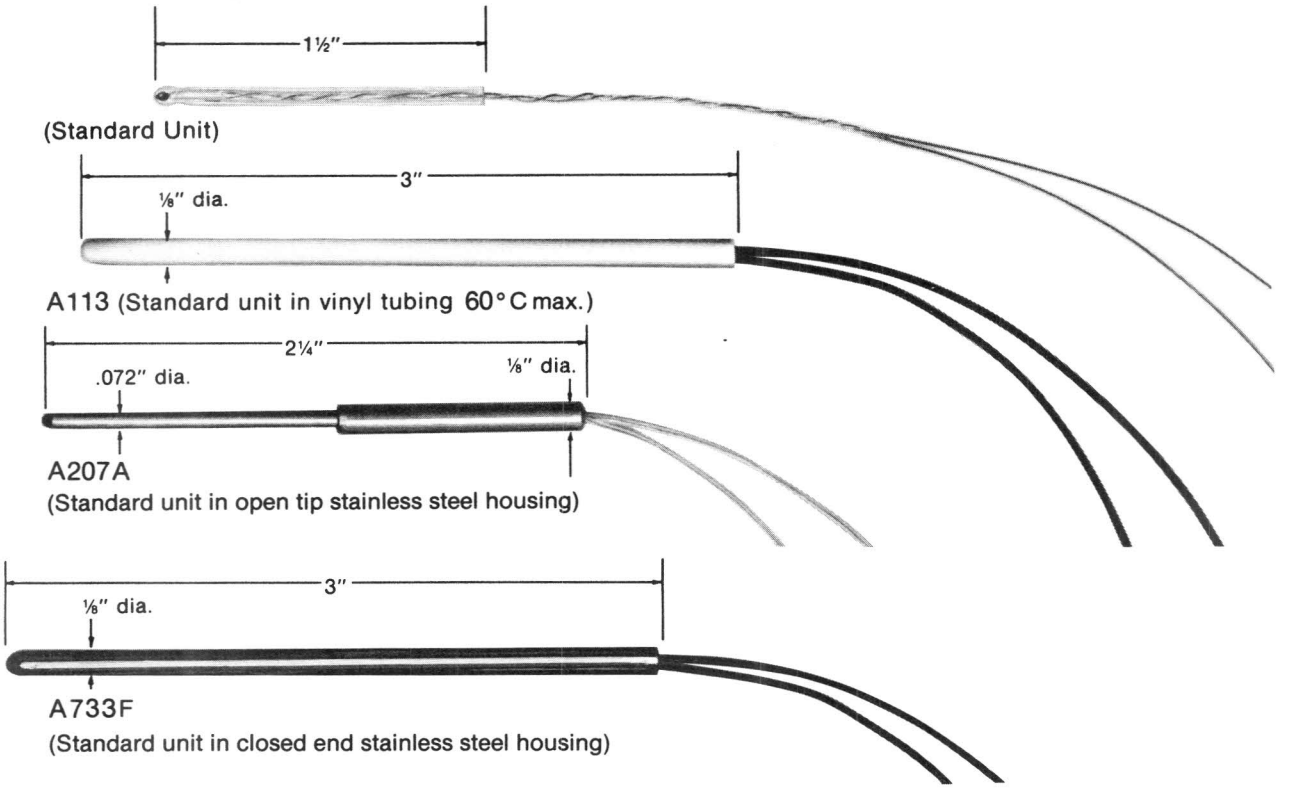
- Non-standard resistance values.
- Non-standard sizes.
- Reference temperature(s) other than 25°C.
- Non-standard tolerances (at 1 or more temperatures).
- Longer or shorter leads.
- Extension leads — specify lead material, diameter, length, and insulation, if any. Also specify if moisture proof seal is desired over joint.
- Special mountings and enclosures.
- Calibration — specify temperatures.
- Interchangeable pairs, sets; curve matching — specify temperature(s) and tolerance(s).
- Special aging for high reliability applications.

PROBE:

- Non standard tube length or diameter.
- Non standard sheath or lead length.
- Non standard tube and materials.
- Hi-temp operation to 450°C.
- Interchangeability — all probes exhibit same resistance vs. temperature characteristics.

TEMPERATURE STANDARDS SERIES CSP

Ultrastable
Calibrated
Low Cost



The Series CSP Temperature Standards are ultrastable probe thermistors which have been calibrated to an accuracy of 0.01°C. The standard unit has a thin, conformal coating of silicone rubber over the entire unit; this makes it suitable for immersion in a water bath. They are also available with stainless steel sensor housings, or they can be encapsulated into various sheaths. See assemblies depicted above.

Two types of Series CSP Thermoprobes are stocked for quick delivery: the CSP60BA252M with a nominal resistance of 2500 ohms @25°C; it is furnished with calibration over the range of 0 to 50°C. The CSP60BT103M has a nominal resistance of 10K ohms @25°C and is furnished with calibration over the range of 0 to 100°C. The calibration table normally furnished with the CSP60BA252M provides data every 0.25°C between 0 and 50°C. The table furnished with the CSP60BT103M provides data every 0.5°C over the range of 0 to 100°C. Both units are furnished with interpolation equations which are accurate to 0.01°C. Tables with calibration data furnished every 0.01, 0.05 or 0.1°C are also available.

All units can be supplied with calibrations over different temperature ranges, with longer leads; and with various coatings. Please contact our Applications Engineering staff for details.

Nominal Curve for CSP60BA252M

Temperature °C	Resistance Ratio R_T/R_{25}	Temperature °C	Resistance Ratio R_T/R_{25}
0.00	2.84438	30.00	0.82461
5.00	2.28160	35.00	0.68340
10.00	1.84096	40.00	0.56913
15.00	1.49390	45.00	0.47620
20.00	1.21899	50.00	0.40025
25.00	1.00000		

Temperature Standards — Series CSP

Nominal Curve for CSP60BT103M

Temperature °C	Resistance Ratio R_T/R_{25}	Temperature °C	Resistance Ratio R_T/R_{25}
0.00	2.94227	65.00	0.23773
5.00	2.33994	70.00	0.20279
10.00	1.87383	75.00	0.17368
15.00	1.51049	80.00	0.14932
20.00	1.22532	85.00	0.12886
25.00	1.00000	90.00	0.11159
30.00	0.82084	95.00	0.09697
35.00	0.67752	100.00	0.08455
40.00	0.56219		
45.00	0.46887		
50.00	0.39295		
55.00	0.33087		
60.00	0.27985		

PRICING

Ordering Code	Description
CSP60BA252M	Nominal resistance 2500 ohms @ 25°C, calibration table every 0.25°C between 0 and 50°C
CSP60BT103M	Nominal resistance 10K ohms @ 25°C, calibration table every 0.5°C between 0 and 100°C

OPTIONS:

A113 - * — Plastic tubing 60°C max.

A207A - * — Open tip stainless steel housing

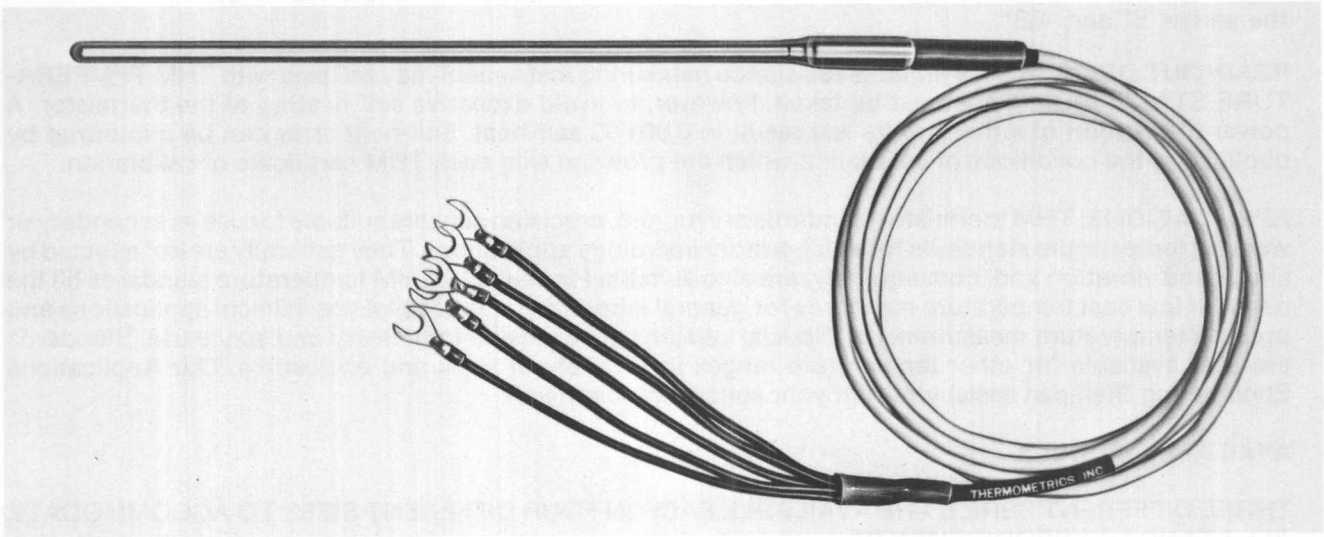
A733F - * — Closed end stainless steel housing

- * CSP60BA252M or CSP60BT103M

OTHER CALIBRATION TABLES ARE AVAILABLE AT ADDITIONAL COST
CONSULT FACTORY FOR DETAILS

TEMPERATURE STANDARDS
SERIES "S", "AS", "ES"

STYLE: Thermometrics temperature standards consist of ultra-stable thermistor probes assembled into thin wall stainless steel housings with shielded extension leads. The thermistors used receive special processing to ensure long term stability. All THM thermistor temperature standards are ruggedly constructed and are suitable for liquid immersion.



CONFIGURATION: THM temperature standards are enclosed in thin-wall stainless tubes, welded closed at one end. The shielded cable is encapsulated into the tube to provide a solid moisture-proof seal. Full immersion of the metal portion of the standard is permissible. The calibration data is given for an immersion depth of 8" on 9" housings, and 4" on 4½" long housings.

TEMPERATURE RANGE: The "S" series and "AS" series are designed for operation over the range of 0° C to 60° C. The "ES" series is rated for 0° C to 100° C.

STABILITY: The stability of each THM temperature standard is guaranteed for a period of one year. When properly used, the following stability ratings apply:

"AS" series: 0.002° C/yr
"S" series: 0.005° C/yr
"ES" series: 0.005° C/yr

RESISTANCE VS. TEMPERATURE CHARACTERISTIC: The nominal resistance values are shown below:

SERIES	RESISTANCE IN OHMS			
	0° C	25° C	60° C	100° C
"AS" & "S"	14250	5000	1458	
"AS" & "S"	11400	4000	1166	
"ES"	28500	10000	2915	925

CALIBRATION: Precision calibration, traceable to the National Bureau of Standards, is provided for all THM temperature standards. A computer generated table in increments of 0.01° C is furnished with each calibration based on the interpolation formula, $R_T = \exp(A_o + A_1/T + A_2/T^2 + A_3/T^3)$. The constants for the formula are obtained from a polynomial regression performed on the calibration data obtained. Over the range of 0° C to 60° C, calibration is performed at the triple point of water (0.01° C) and 15° C, 25° C, 30° C, 37° C, 50° C, and 60° C. For the range of 0° C to 100° C, calibrations are performed at the triple point of water, 25° C, 30° C, 37° C, 60° C, 80° C, and 100° C. Two-wire calibrations are performed using a Wheatstone Bridge calibrated to an accuracy of better than 0.005%. Four-wire calibrations are based on a comparison technique using a ratio bridge having an accuracy of 0.0002%. All resistance measurements are referenced to standard resistors calibrated by NBS. All temperature measurements are made using a standard platinum resistance thermometer which has been calibrated by NBS.

ACCURACY: The calibration accuracies of THM Temperature Standards (at-time of sale) are as follows:

SERIES	ACCURACY	
	0° C-60° C	60° C-100° C
"AS"	0.001° C	
"S"	0.0015° C	
"ES"	0.0015° C	0.0025° C

The uncertainties of the computer tables are 0.001° C for the series "AS" and 0.003° C for the series "S" and "ES".

READ-OUT DEVICES: Any suitable resistance measuring instrument may be used with THM TEMPERATURE STANDARDS. Care must be taken, however, to avoid excessive self-heating of the thermistor. A power dissipation of 4 microwatts will result in 0.001° C self-heat. Self-heat error can be minimized by duplicating the conditions of calibration which are provided with each THM certificate of calibration.

APPLICATIONS: THM thermistor standards are rugged, precision sensors suitable for use as secondary or working temperature standards for all laboratory metrology applications. They generally are not affected by shock and vibration and, consequently, are also suitable for field use. THM temperature standards fill the need for low cost temperature standards for general laboratory and hospital use, clinical applications and process temperature measurements. Special versions are available for military and space use. Standards are also available for other temperature ranges in a variety of sizes and enclosures. Our Applications Engineering Staff can assist you with your specific requirements.

AVAILABLE MODELS

THREE DIFFERENT SERIES ARE AVAILABLE EACH IN FOUR DIFFERENT SIZES TO ACCOMMODATE ALL STANDARD REQUIREMENTS:

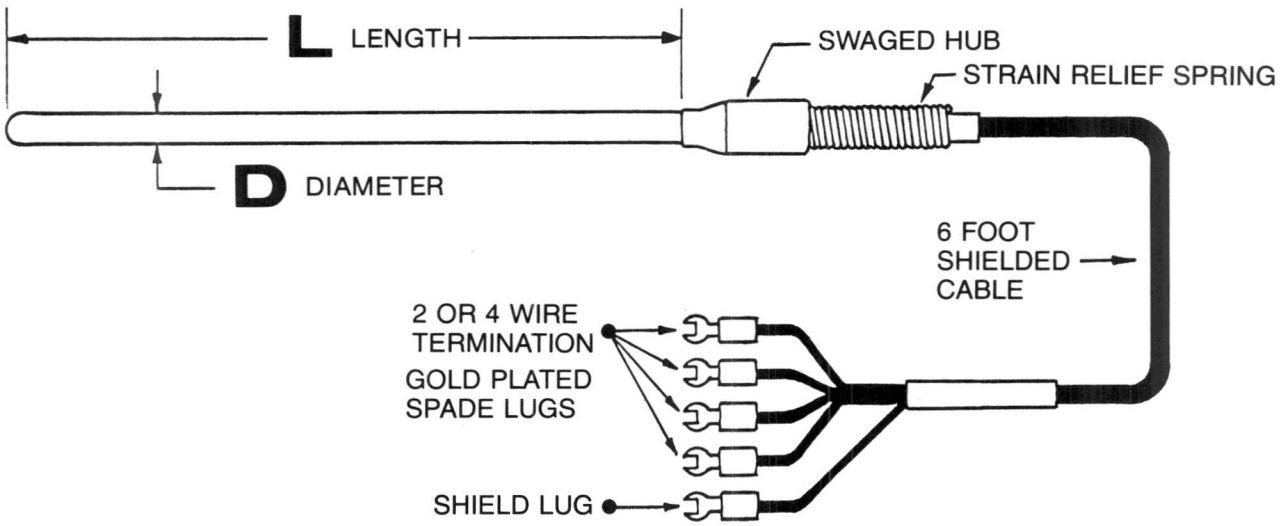
SERIES "S" which includes S10, S15, S20, S25 offer standard 0.005° C/yr stability and temperature range 0° to 60° C.
SERIES "AS" which includes AS110, AS115, AS120, AS125 offer 0.002° C/yr stability and temperature range 0° to 60° C.
SERIES "ES" which includes ES210, ES215, ES220, ES225 offer 0.005° C/yr stability and temperature range 0° to 100° C.

DIMENSIONS AND SUMMARY INFORMATION

Dimensions in Inches ( ) Dia x ( ) Long	Standard Series "S"	Stability °C/Year	Absolute Series "AS"	Stability °C/Year	Temp. Range for "S" & "AS" °C	Extended Temp. Range	Stability °/Year °C	Temp. Range "ES" °C
1/4" x 9"	S10	0.005	AS110	0.002	0-60	ES210	0.005	0-100
1/8" x 4 1/2"	S15	0.005	AS115	0.002	0-60	ES215	0.005	0-100
1/4" x 4 1/2"	S20	0.005	AS120	0.002	0-60	ES220	0.005	0-100
1/8" x 9"	S25	0.005	AS125	0.002	0-60	ES225	0.005	0-100

ORDERING INFORMATION All temperature standards series "S", "AS" & "ES" may be ordered by part number and are availble in two-wire and four-wire terminations. Unless otherwise specified a two-wire termination will be supplied. If a four-wire termination is desired specify by adding the suffix "4 wire". Therefore an ES220 unit in 4-wire is ordered as "ES220-4 wire".

RECALIBRATION SERVICES: Thermometrics offers a recalibration recertification service for temperature standards series "S" "AS" & "ES". For the series "S", the units are initially evaluated at the triple point of water and 25° C. The series "ES" are evaluated at the triple point of water, 37° C, and 100° C. If the calibrations repeat their original values within the published accuracy, then recertification is provided. If not, then complete recalibration is required if the stability has not been impaired. The series "AS" can only be recertified after complete recalibration.



RESISTANCE RATIO VS. TEMPERATURE

To find the Thermistor Resistance at any specified temperature, multiply the Resistance Ratio given by the Resistance at 25° C.

TABLE NO.		1	2	3	4	5	6	7	8
BETA: 25-125° C (KELVIN)		2930	2997	3133	3359	3548	3672	3708	4015
RATIO: 25° C/125° C		11.80	12.48	14.01	16.94	19.86	22.06	22.73	29.43
RATIO: 0° C/50° C		5.177	5.344	5.658	6.362	7.038	7.438	7.583	9.115
TC: α25° C (%/° C)		-3.27	-3.33	-3.44	-3.67	-3.88	-3.98	-4.02	-4.39
°F	°C								
-112	-80	139.7	152.5	175.3	232.4				
-103	-75	101.6	109.5	125.1	164.4				
- 94	-70	74.52	79.51	90.27	117.4				
- 85	-65	55.15	58.40	65.87	84.64				
- 76	-60	41.19	43.36	48.58	61.59	76.05	87.56	91.62	143.2
- 67	-55	31.04	32.54	36.19	45.25	54.97	62.37	65.05	98.02
- 58	-50	23.61	24.66	27.24	33.55	40.15	44.97	46.74	68.03
- 49	-45	18.12	18.87	20.70	25.11	29.62	32.79	33.97	47.83
- 40	-40	14.03	14.58	15.87	18.97	22.06	24.16	24.96	34.04
- 31	-35	10.95	11.36	12.28	14.45	16.59	17.99	18.53	24.52
- 22	-30	8.625	8.926	9.580	11.10	12.59	13.53	13.89	17.86
- 13	-25	6.848	7.071	7.536	8.604	9.632	10.27	10.51	13.14
- 4	-20	5.479	5.645	5.974	6.721	7.433	7.863	8.025	9.772
+ 5	-15	4.418	4.540	4.772	5.291	5.783	6.072	6.181	7.337
14	-10	3.589	3.677	3.839	4.197	4.534	4.728	4.800	5.559
23	- 5	2.935	2.998	3.110	3.353	3.581	3.709	3.757	4.250
32	0	2.418	2.460	2.536	2.698	2.849	2.932	2.962	3.276
41	5	2.004	2.032	2.081	2.185	2.282	2.334	2.353	2.546
50	10	1.672	1.688	1.718	1.781	1.840	1.870	1.881	1.994
59	15	1.403	1.410	1.427	1.461	1.493	1.509	1.515	1.573
68	20	1.185	1.184	1.192	1.206	1.218	1.224	1.227	1.250
77	25	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
86	30	.8572	.8494	.8440	.8344	.8262	.8215	.8197	.8051
95	35	.7338	.7239	.7155	.6994	.6860	.6785	.6757	.6524
104	40	.6295	.6197	.6094	.5892	.5725	.5633	.5600	.5318
113	45	.5414	.5329	.5215	.4987	.4802	.4701	.4665	.4360
122	50	.4671	.4603	.4482	.4241	.4048	.3942	.3906	.3594
131	55	.4044	.3993	.3869	.3623	.3428	.3321	.3285	.2979
140	60	.3515	.3479	.3353	.3108	.2917	.2811	.2776	.2481
149	65	.3068	.3042	.2917	.2677	.2492	.2390	.2356	.2077
158	70	.2689	.2671	.2548	.2316	.2138	.2040	.2008	.1747
167	75	.2367	.2355	.2234	.2011	.1842	.1748	.1719	.1476
176	80	.2093	.2083	.1965	.1753	.1593	.1504	.1477	.1253
185	85	.1859	.1849	.1735	.1533	.1383	.1299	.1274	.1067
194	90	.1659	.1648	.1536	.1346	.1205	.1126	.1102	.09134
203	95	.1487	.1473	.1365	.1185	.1054	.09794	.09575	.07846
212	100	.1339	.1321	.1217	.1048	.09245	.08547	.08346	.06766
221	105	.1212	.1188	.1088	.09285	.08138	.07484	.07298	.05856
230	110	.1101	.1072	.09750	.08256	.07186	.06573	.06402	.05085
239	115	.1005	.09700	.08764	.07362	.06364	.05791	.05633	.04432
248	120	.09208	.08802	.07900	.06583	.05654	.05117	.04971	.03875
257	125	.08475	.08010	.07139	.05903	.05036	.04534	.04400	.03398
266	130	.07832	.07308	.06467	.05307	.04487	.04029	.03905	.02990
275	135	.07267	.06684	.05873	.04784	.04023	.03589	.03475	.02638
284	140	.06769	.06129	.05345	.04323	.03619	.03209	.03100	.02334
293	145	.06330	.05633	.04876	.03915	.03264	.02872	.02772	.02071
302	150	.05940	.05189	.04458	.03555	.02953	.02577	.02485	.01843
311	155	.05595	.04791	.04085	.03234	.02680	.02318	.02233	.01644
320	160	.05288	.04433	.03750	.02949	.02438	.02090	.02011	.01470
329	165					.02224	.01887	.01815	.01318
338	170					.02033	.01708	.01642	.01184
347	175					.01864	.01550	.01489	.01066
356	180					.01713	.01409	.01353	.009623
365	185					.01577	.01283	.01231	.008703
374	190					.01456	.01171	.01123	.007888
383	195					.01347	.01071	.01027	.007164
392	200					.01248	.009811	.009401	.006519
401	205					.01159	.009004	.008624	.005943
410	210					.01079	.008278	.007925	.005428
419	215					.01006	.007624	.007295	.004966
428	220					.009395	.007033	.006727	.004552
437	225					.008790	.006499	.006214	.004179
446	230					.008239	.006014	.005749	.003843
455	235					.007735	.005575	.005326	.003539
464	240					.007274	.005175	.004943	.003265
473	245					.006850	.004811	.004594	.003016
482	250					.006462	.004479	.004275	.002791
491	255					.006104	.004176	.003985	.002586
500	260					.005774	.003899	.003719	.002399

NOTES:

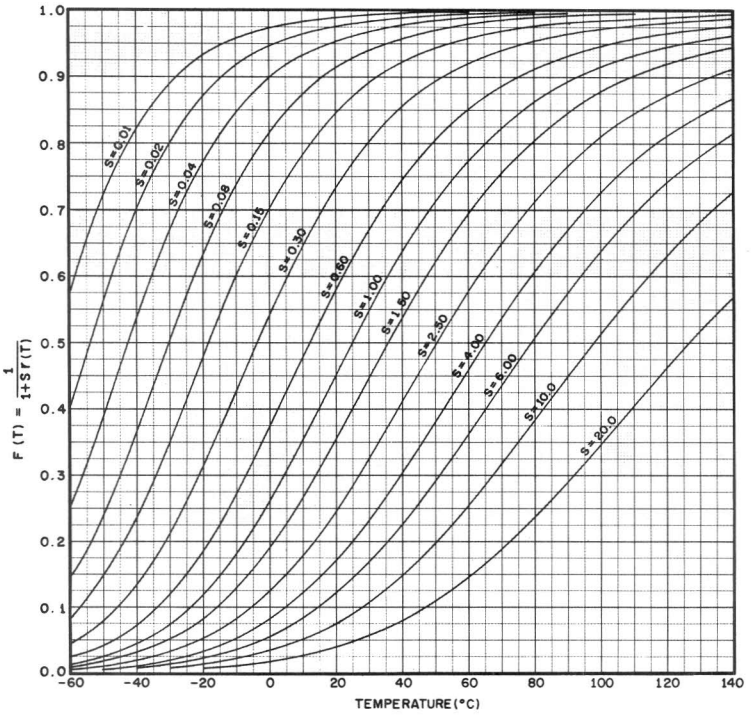
1. Table values do not take into account leadwire resistance values which can have a significant effect on ratio values obtained when using low resistance devices. This is particularly true at high temperatures.
2. These tables are plotted as curves on the inside back cover. The plotted curves facilitate interpolation between the temperature points given in the tables.

RESISTANCE RATIO VS. TEMPERATURE

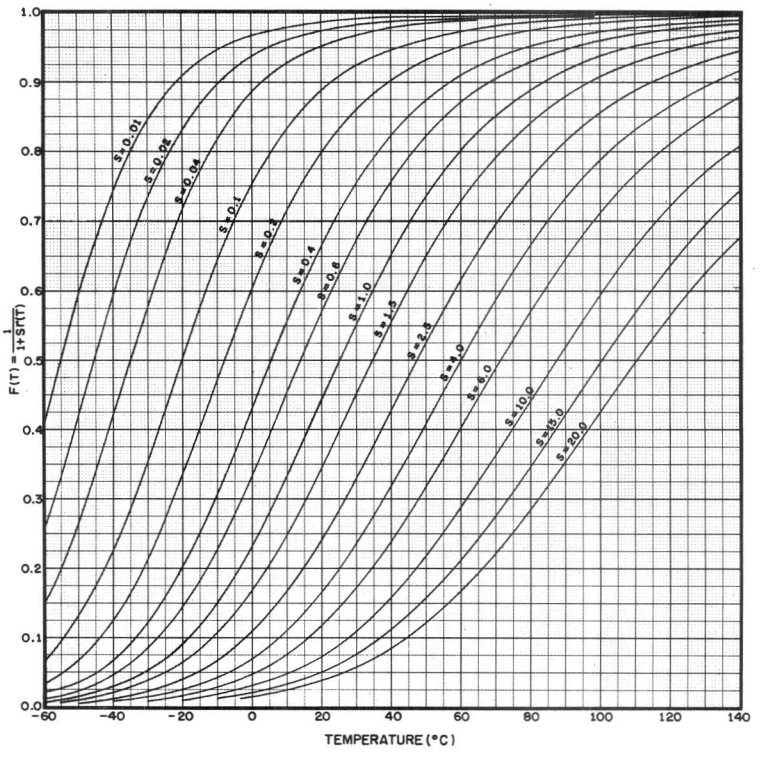
To find the Thermistor Resistance at any specified temperature, multiply the Resistance Ratio given by the Resistance at 25° C.

9	10	11	12	13	14	15	16	TABLE NO.	
4069 30.80 9.355 -4.44	4125 32.39 9.598 -4.49	4243 35.68 10.11 -4.59	4320 38.05 10.43 -4.66	4520 45.05 11.44 -4.84	4598 48.10 11.88 -4.91	4790 56.53 13.19 -5.12	5135 75.64 15.60 -5.46	BETA: 25-125° C (KELVIN) RATIO: 25° C/125° C RATIO: 0° C/50° C TC: α 25° C (%/° C)	
								°F	°C
								-112	-80
								-103	-75
								- 94	-70
								- 85	-65
151.1	157.1	165.9	176.2	202.0	212.5	223.1	349.5	- 76	-60
103.1	107.0	114.1	119.7	136.7	143.7	155.2	228.4	- 67	-55
71.27	73.88	79.22	82.32	93.51	98.20	108.1	151.1	- 58	-50
49.94	51.66	55.52	57.30	64.71	67.83	75.55	101.2	- 49	-45
35.42	36.57	39.27	40.34	45.26	47.34	53.04	68.51	- 40	-40
25.42	26.19	28.05	28.72	31.99	33.37	37.44	46.89	- 31	-35
18.45	18.97	20.23	20.67	22.84	23.76	26.58	32.43	- 22	-30
13.53	13.88	14.73	15.03	16.47	17.08	19.00	22.65	- 13	-25
10.03	10.26	10.82	11.03	11.99	12.39	13.68	15.97	- 4	-20
7.507	7.663	8.029	8.175	8.806	9.072	9.924	11.37	+ 5	-15
5.671	5.774	6.010	6.114	6.526	6.700	7.252	8.161	14	-10
4.322	4.390	4.538	4.612	4.878	4.989	5.340	5.910	23	- 5
3.322	3.364	3.452	3.508	3.676	3.746	3.963	4.315	32	0
2.574	2.600	2.654	2.689	2.792	2.835	2.964	3.175	41	5
2.010	2.027	2.056	2.078	2.137	2.161	2.233	2.355	50	10
1.582	1.591	1.605	1.617	1.647	1.661	1.696	1.759	59	15
1.253	1.258	1.262	1.268	1.279	1.284	1.297	1.323	68	20
1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	77	25
.8033	.8017	.7963	.7946	.7872	.7844	.7756	.7638	86	30
.6493	.6462	.6387	.6352	.6235	.6190	.6066	.5868	95	35
.5280	.5240	.5153	.5109	.4969	.4915	.4771	.4537	104	40
.4318	.4274	.4183	.4133	.3984	.3926	.3775	.3531	113	45
.3551	.3505	.3414	.3362	.3212	.3154	.3005	.2766	122	50
.2936	.2890	.2801	.2749	.2603	.2547	.2405	.2179	131	55
.2440	.2396	.2311	.2260	.2122	.2069	.1936	.1727	140	60
.2038	.1996	.1916	.1868	.1738	.1689	.1567	.1376	149	65
.1710	.1670	.1596	.1550	.1430	.1385	.1275	.1103	158	70
.1442	.1405	.1335	.1293	.1183	.1142	.1042	.08884	167	75
.1221	.1186	.1122	.1083	.09826	.09453	.08559	.07193	176	80
.1038	.1006	.09774	.09115	.08199	.07863	.07064	.05854	185	85
.08862	.08572	.08031	.07701	.06870	.06568	.05857	.04786	194	90
.07596	.07331	.06835	.06533	.05781	.05509	.04877	.03932	203	95
.06535	.06294	.05839	.05563	.04883	.04640	.04079	.03245	212	100
.05644	.05424	.05008	.04755	.04141	.03923	.03425	.02689	221	105
.04891	.04691	.04309	.04079	.03525	.03329	.02887	.02238	230	110
.04253	.04071	.03722	.03511	.03011	.02836	.02443	.01871	239	115
.03710	.03545	.03225	.03033	.02581	.02424	.02075	.01570	248	120
.03247	.03097	.02803	.02628	.02220	.02079	.01769	.01322	257	125
.02851	.02714	.02445	.02284	.01915	.01789	.01514	.01118	266	130
.02509	.02386	.02138	.01992	.01658	.01545	.01299	.009485	275	135
.02216	.02104	.01876	.01742	.01440	.01338	.01120	.008077	284	140
.01962	.01860	.01650	.01528	.01254	.01162	.009680	.006901	293	145
.01742	.01649	.01456	.01344	.01095	.01012	.008394	.005916	302	150
.01551	.01466	.01287	.01185	.009588	.008844	.007300	.005088	311	155
.01384	.01307	.01142	.01048	.008420	.007748	.006367	.004390	320	160
.01238	.01167	.01015	.009286	.007413	.006806	.005568	.003799	329	165
.01111	.01046	.009044	.008251	.006543	.005994	.004883	.003297	338	170
.009986	.009387	.008078	.007349	.005790	.005293	.004292	.002870	347	175
.008998	.008447	.007232	.006561	.005136	.004685	.003783	.002505	356	180
.008126	.007617	.006489	.005870	.004566	.004156	.003342	.002193	365	185
.007354	.006884	.005835	.005264	.004068	.003696	.002959	.001924	374	190
.006669	.006234	.005258	.004730	.003633	.003294	.002626	.001693	383	195
.006060	.005657	.004747	.004259	.003251	.002942	.002335	.001494	392	200
.005518	.005144	.004294	.003843	.002915	.002633	.002081	.001321	401	205
.005034	.004686	.003892	.003474	.002620	.002362	.001858	.001171	410	210
.004600	.004276	.003534	.003146	.002359	.002123	.001662	.001040	419	215
.004212	.003910	.003215	.002855	.002128	.001911	.001490	.0009259	428	220
.003864	.003581	.002930	.002595	.001923	.001724	.001338	.0008263	437	225
.003550	.003285	.002675	.002363	.001741	.001559	.001204	.0007389	446	230
.003267	.003019	.002446	.002155	.001579	.001411	.001085	.0006621	455	235
.003011	.002779	.002240	.001969	.001434	.001280	.0009796	.0005946	464	240
.002780	.002561	.002055	.001802	.001305	.001163	.0008858	.0005349	473	245
.002571	.002365	.001887	.001651	.001190	.001059	.0008023	.0004822	482	250
.002381	.002186	.001737	.001516	.001086	.0009649	.0007278	.0004355	491	255
.002208	.002024	.001600	.001393	.0009931	.0008810	.0006612	.0003940	500	260

S-CURVES



F(T) vs. TEMPERATURE – "A" MATERIAL

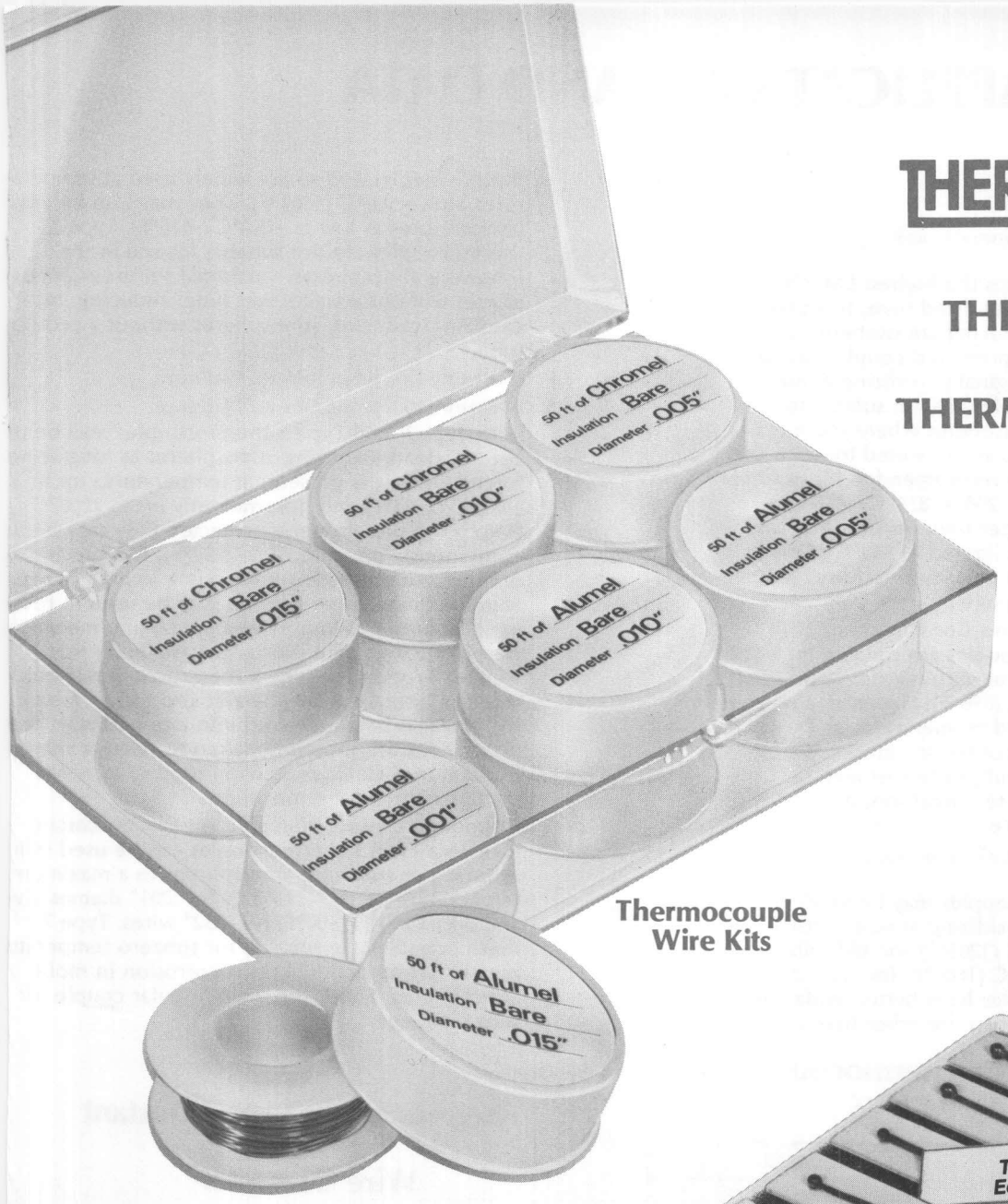


F(T) vs. TEMPERATURE – "B" MATERIAL

THERMOMETRICS 808 U.S. HIGHWAY 1 EDISON, NEW JERSEY 08817 TEL. 201-287-2870

THERMOMETRICS INC.

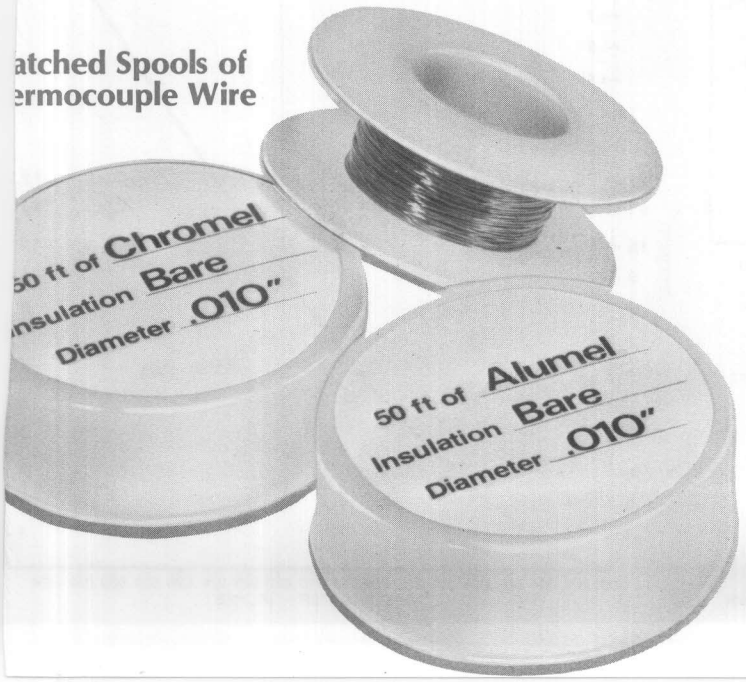
Fine Gauge THERMOCOUPLES and THERMOCOUPLE WIRE



Thermocouple Wire Kits

Fine Gauge, Bare Wire Thermocouples

atched Spools of
ermocouple Wire



TECHNICAL APPLICATIONS AND DATA

Thermocouple Selection

Type E **Nickel-Chromium vs. Copper-Nickel (Chromel†-Constantan)**

This thermocouple develops the highest EMF/°C or °F of any of the thermocouples listed here. It is used in inert, oxidizing, or dry reducing atmospheres, protected or unprotected. A protected couple may be used in sulfurous and marginally oxidizing atmospheres. These thermocouples are not subject to corrosion in subzero atmospheres where there is a high moisture content and so are suited for such use. Type E thermocouples are recommended for use over the temperature range of -250 to 870°C (-418 to 1598°F). However, the upper temperature limit for .032" diameter size wire is limited to 540°C (1004°F). Smaller wire diameters are restricted to lower temperature limits; see table on page 3.

Type J **Iron vs. Copper Nickel (Iron-Constantan)**

Fine wire Type J thermocouples are suitable for use in oxidizing, reducing, inert or vacuum atmospheres at temperatures up to 480°C (896°F). However, the iron oxidizes rapidly at elevated temperatures and wire sizes below .020" should not be operated above 370°C (698°F). Since the iron is subject to rust and embrittlement at subzero temperatures, it is not recommended for such use.

Type K **Nickel-Chromium vs. Nickel-Aluminum (Chromel-Alumel†)**

Type K fine wire thermocouples may be used continuously in inert or oxidizing atmospheres at temperatures up to 649°C (1200°F) for .001" diameter bare wire, and up to 982°C (1800°F) for .032" diameter bare couples. These couples have better oxidation resistance characteristics than the other base metal thermocouples and so are widely used at temperatures above 540°C (1004°F). They may also be used temperatures as low as -250°C (-428°F). Type K thermocouples are not suitable for use in the following atmospheres: vacuums; sulfurous atmospheres without a protection tube; reducing, or oxidizing/reducing atmospheres without a protect tube.

Type R **Platinum-13% Rhodium vs. Platinum**

Type S **Platinum-10% Rhodium vs. Platinum**

Both Type R and Type S thermocouples may be us bare in clean, oxidizing atmospheres as long as no forced air flow is present, at temperatures up to 1400°C (2552°F) and intermittently up to 1750°C (3182°F). When properly protected they may be us continuously up to 1500°C (2732°F). If protected b nonmetallic protection tubes, such as high purity alumina tubes, these couples may be used in redu atmospheres, or atmospheres containing metallic v pors or such volatile substances as zinc or lead. Neither Type R nor Type S thermocouples should inserted directly into a metallic protection tube without first being inserted into a nonmetallic pro tion tube. Care should be taken to select a very h purity non-metallic protection tube so as not to contaminate the thermocouple.

Type T **Copper vs. Copper-Nickel (Copper-Constantan)**

Fine wire Type T thermocouples can be used in ir reducing or oxidizing atmospheres to a maximum temperature of 150°C (302°F) for .001" diameter w and up to 260°C (500°F) for .032" wires. Type T thermocouples are suitable for subzero temperatu measurements and will resist corrosion in moist atmospheres. This is the most popular couple for subzero usage.

*Limits of Error for Thermocouples

REFERENCE JUNCTION 0°C

Thermocouple Type	Temperature Range °C	LIMITS OF ERROR Standard (whichever is greater)	LIMITS OF ERROR SPECIAL (whichever is greater)
T	0 to 350	± 1°C or ± 0.75%	± 0.5°C or ± 0.4%
J	0 to 750	± 2.2°C or ± 0.75%	± 1.1°C or ± 0.4%
E	0 to 900	± 1.7°C or ± 0.5%	± 1°C or ± 0.4%
K	0 to 1250	± 2.2°C or ± 0.75%	± 1.1°C or ± 0.4%
R or S	0 to 1450	± 1.5°C or ± 0.25%	± 0.6°C or ± 0.1%
B	800 to 1700	± 0.5%	—
T*	-200 to 0°C	± 1°C or ± 1.5%	**
E*	-200 to 0°C	± 1.7°C or ± 1%	**
K*	-200 to 0°C	± 2.2°C or ± 2%	**

*Thermocouples and thermocouple materials are normally supplied to meet the limits of error specified in the table for temperatures above 0°C. The same materials, however, may not fall within the sub-zero limits of error given in the second section of the table. If materials are required to meet the sub-zero limits, special materials must be ordered.

**Little information is available to justify establishing special limits of error for sub-zero temperatures. Limited experience suggests the following limits for types E and T thermocouples:

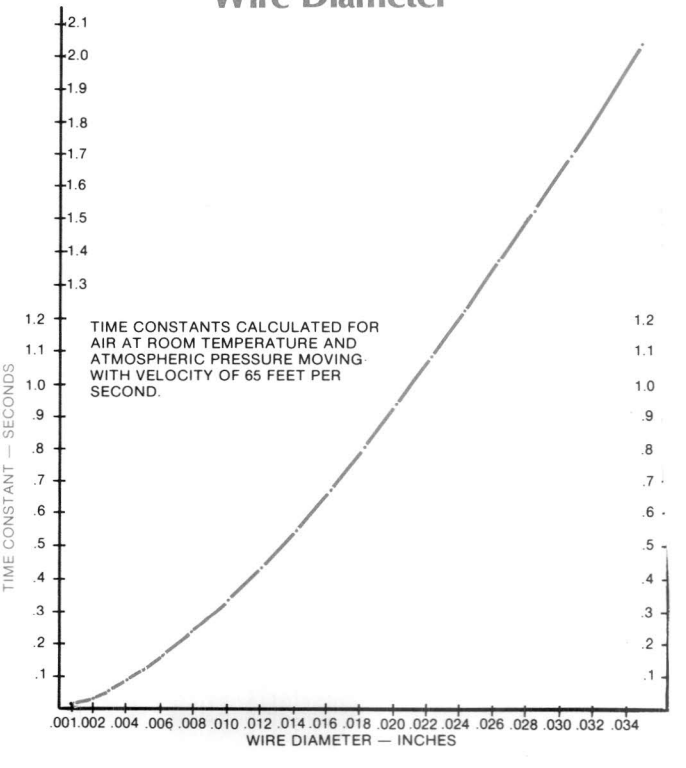
Type E -200 to 0°C ± 1°C or ± 0.5%
Type T -200 to 0°C ± 0.5°C or ± 0.8%

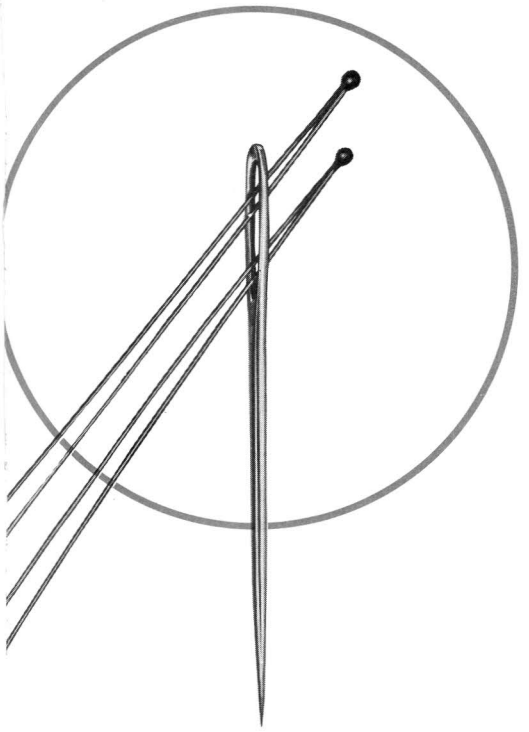
These limits are given only as a guide.

Due to the characteristics of the materials, sub-zero limits of error for Type J thermocouples and special sub-zero limits for Type K thermocouples are not listed.

†Chromel and Alumel are registered trademarks of the Hoskins Manufacturing Company.

Thermocouple Time Constant vs Wire Diameter





ermocouples fine enough fit through the eye of a needle.

*Recommended Upper Temperature Limits for Fine Gauge, Bare Wire Thermocouples and Thermocouple Wire (Degrees F)

Type	.001	.002	.003	.005	.010	.015	.020	.032
E	600°F	650°F	700°F	700°F	800°F	800°F	800°F	1000°F
J	500	600	600	600	700	700	700	900
K	1200	1300	1400	1400	1400	1600	1600	1800
T	300	300	350	350	400	400	400	500
Chromel	1200°F	1300°F	1400°F	1400°F	1400°F	1600°F	1600°F	1800°F
Alumel	1200	1300	1400	1400	1400	1600	1600	1800
Constantan	600	650	700	700	800	800	800	1000
Iron	500	600	600	600	700	700	700	900

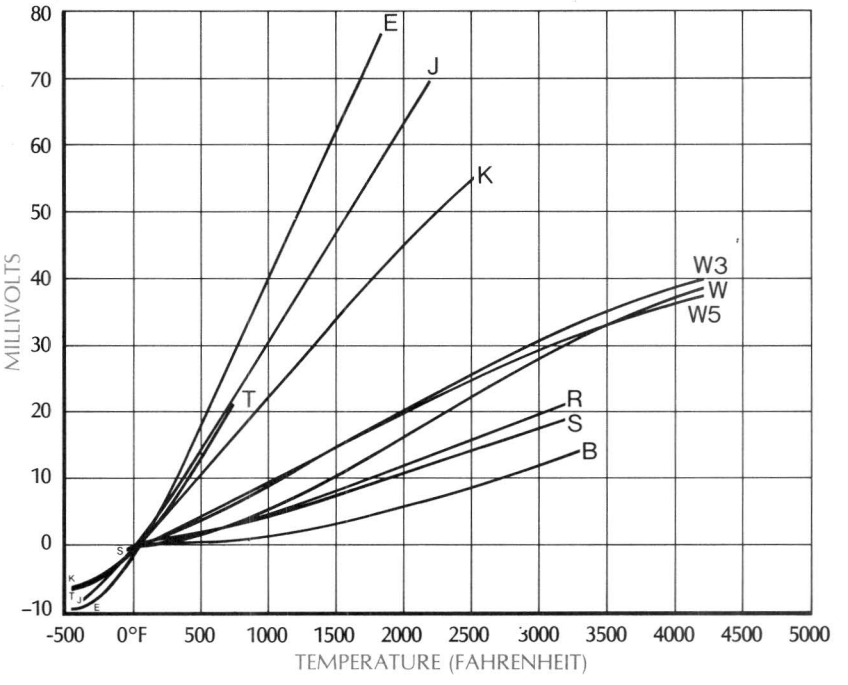
*Adherence to the temperature limits listed above will generally provide a satisfactory thermocouple life. In actual operation there may be instances where these limits may be exceeded for brief intervals. However, since we cannot control the environment in which they are used the above recommendations cannot be taken as a guarantee of performance.

Key to Symbols

E	Chromel-Constantan
J	Iron-Constantan
K	Chromel-Alumel
T	Copper-Constantan
B	Platinum 6% Rhodium vs. Platinum 30% Rhodium
R	Platinum vs. Platinum 13% Rhodium
S	Platinum vs. Platinum 6% Rhodium
W/W26Re	Tungsten vs. Tungsten 26% Rhenium
W5Re/W26Re	Tungsten 5% Rhenium vs. Tungsten 26% Rhenium
W3Re/W25Re	Tungsten 3% Rhenium vs. Tungsten 25% Rhenium

Data sources: NBS Monograph 125 and Hoskins Manufacturing Company

Temperature-Millivolt Graph for Thermocouples



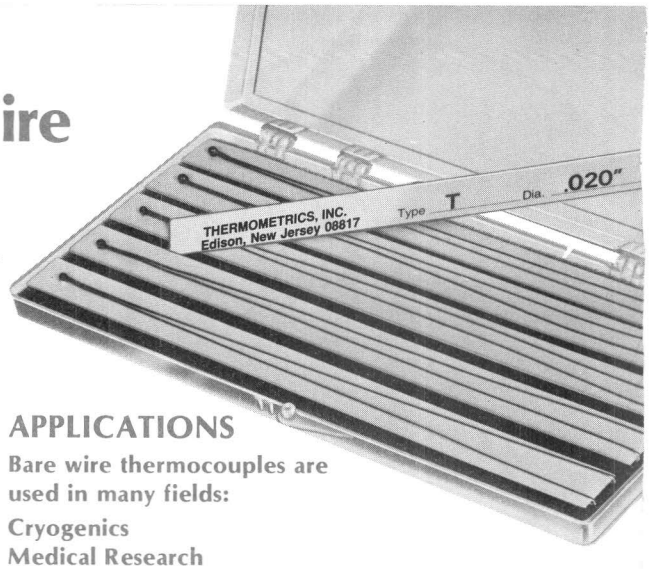
Wire Size vs. Resistance for Thermocouple Wire

[Resistance in ohms per single foot at 20°C (68°F)]

AWG.	DIAMETER Inches	DIAMETER mm	ALUMEL (KN)	CHROMEL (EP,KP)	CONSTAN-TAN (EN,JN,TN)	COPPER (TP)	IRON (JP)	PLATINUM (RN,SN)	PLATINUM 13% RHODIUM (RP)	PLATINUM 10% RHODIUM (SP)
20	.032	.8818	.1729	.4155	.2871	.100	.0732	.063	.115	.113
24	.0201	.5105	.4381	1.052	.7277	.2541	.1856	.160	.293	.289
26	.015	.4049	.700	1.681	1.162	.4006	.2967	.284	.521	.513
30	.010	.2548	1.77	4.25	2.940	1.026	.7500	.640	1.173	1.154
32	.008	.2019	2.766	6.641	4.594	1.0604	1.171	1.0	1.832	1.803
36	.005	.1270	7.08	17.0	11.76	4.106	3.0	2.56	4.692	4.616
40	.00315	.0799	17.838	42.832	29.63	10.34	7.56	6.45	11.824	11.633
44	.002	.0508	44.25	106.25	73.5	25.66	18.75	16.0	29.325	28.85
50	.001	.0255	177.0	425.0	294.0	102.67	75.0	64.0	117.3	115.4
56	.00049	.0124	737.193	1770.1	1224.5	428.51	312.37	266.56	488.54	480.63

Note: All resistances were calculated from data provided by the wire fabricators.

5 Pack of Fine Gauge, Bare Wire THERMOCOUPLES



Thermometrics manufactures fine gauge, bare wire thermocouples which offer faster, more precise temperature measurements than larger diameter thermocouples produced from like materials. Fine wire diameters respond more rapidly because thermal capacity is small.

In addition to speed and accuracy, fine gauge, bare wire thermocouples offer the benefits of a minimum disturbance to flow and temperature in the environment field in which they are introduced. Mechanical and thermal shock have minimal effects on thermocouples.

All of Thermometrics' thermocouples are made from matched pairs of wire and are supplied to fall within the *Standard Limits of Error for Thermocouples* established in the ANSI publication MC 96.1, 1975.

Base metal thermocouples:
Type E Chromel-Constantan
Type J Iron-Constantan
Type K Chromel-Alumel
Type T Copper-Constantan
are supplied in the following diameters: .001", .002", .003", .005", .010", .015", .020", and .032" with a twelve inch immersion length, plus approximately 3/4 inch additional length for hook-up. Type E and Type K are also available in the ultra-fine gauge .0005" diameter with an eight inch immersion length, with approximately 1/2 inch for hook-up.

Noble metal thermocouples:
Type R Platinum-13% Rhodium vs. Platinum
Type S Platinum-10% Rhodium vs. Platinum
are supplied in diameters of .001", .002", .003", .005", .008", .010", .015", .020", and .032" with a six inch immersion length, with about 1/4 inch additional length for hook up.

APPLICATIONS

Bare wire thermocouples are used in many fields:

Cryogenics
Medical Research
Biological Research
Gas Chromatography
Biophysics
Petrochemical Processing
Scientific Instrumentation
Chemical Research
Chemical Processing
Avionics
Nuclear Instrumentation
Paper Manufacture
Industrial Heating
Internal Combustion Test

For ease of identification, the negative leg is always short than the positive leg.

All bare wire, fine gauge thermocouples are available as singles, or in our **ECONOMY FIVE PACK.** In the five pacl couple is individually mounted on a plastic strip which identifies the thermocouple type, wire diameter and imm sion length. For protection and ease of handling the strip inserted into a padded plastic case.

Ordering Information

ANSI Type	Wire Components (Positive leg listed first)	Part Number	Wire Diameter	Immersion Length
E	Nickel-Chromium vs. Copper-Nickel (Chromel-Constantan)	E-0005-5TC	0.0005	8 inches
		E-001-5TC	0.001	12 inches
		E-002-5TC	0.002	
		E-003-5TC	0.003	
		E-005-5TC	0.005	
		E-010-5TC	0.010	
		E-015-5TC	0.015	
		E-020-5TC	0.020	
		E-032-5TC	0.032	12 inches
J	Iron vs. Copper-Nickel (Iron-Constantan)	J-001-5TC	0.001	12 inches
		J-002-5TC	0.002	
		J-003-5TC	0.003	
		J-005-5TC	0.005	
		J-010-5TC	0.010	
		J-015-5TC	0.015	
		J-020-5TC	0.020	
		J-032-5TC	0.032	12 inches
K	Nickel-Chromium vs. Nickel-Aluminum (Chromel-Alumel)	K-0005-5TC	0.0005	8 inches
		K-001-5TC	0.001	12 inches
		K-002-5TC	0.002	
		K-003-5TC	0.003	
		K-005-5TC	0.005	
		K-010-5TC	0.010	
		K-015-5TC	0.015	
		K-020-5TC	0.020	
		K-032-5TC	0.032	12 inches

ANSI Type	Wire Components (Positive leg listed first)	Part Number	Wire Diameter	Immersion Length
R	Platinum 13% Rhodium vs. Platinum	R-001-5TC	0.001	6 inches
		R-002-5TC	0.002	
		R-003-5TC	0.003	
		R-005-5TC	0.005	
		R-008-5TC	0.008	
		R-010-5TC	0.010	
		R-015-5TC	0.015	
		R-020-5TC	0.020	
		R-032-5TC	0.032	6 inches
S	Platinum 10% Rhodium vs. Platinum	S-001-5TC	0.001	6 inches
		S-002-5TC	0.002	
		S-003-5TC	0.003	
		S-005-5TC	0.005	
		S-008-5TC	0.008	
		S-010-5TC	0.010	
		S-015-5TC	0.015	
		S-020-5TC	0.020	
		S-032-5TC	0.032	6 inches
T	Copper vs. Copper-Nickel (Copper-Constantan)	T-001-5TC	0.001	12 inches
		T-002-5TC	0.002	
		T-003-5TC	0.003	
		T-005-5TC	0.005	
		T-010-5TC	0.010	
		T-015-5TC	0.015	
		T-020-5TC	0.020	
		T-032-5TC	0.032	12 inches

THERMOMETRICS INC.
808 U.S. HIGHWAY 1, EDISON, N.J. 08817
PHONE: (201) 287-2870

Ordering Notes

All items listed are shipped from inventory.

Production quantities of thermocouples are available to manufacturers at O.E.M. pricing. Consult factory for details. Special size and/or alloys are also available; contact factory for price quotatior and delivery time.

THERMOCOUPLE WIRE KITS
12 SPOOLS

Protective cover mechanically protects wire, prevents wire snags, may be handled with ease!

4 DIFFERENT KITS

Kit E Chromel and Constantan
Kit J Iron and Constantan
Kit K Chromel and Alumel
Kit T Copper and Constantan

6 Wire Sizes in each kit

.001" dia.
.002" dia.
.003" dia.
.005" dia.
.010" dia.
.015" dia.

Thermometrics recognizes the needs of individuals in research, education and industry for small quantities of fine gauge thermocouple wire. These kits are designed to provide a comprehensive variety of wire sizes of the highest quality materials at a reasonable price. The wire can be used to form thermocouples that will fall within the ANSI "Limits of Error for Thermocouples"; provided they are produced using standard manufacturing practices. There are several excellent sources that delineate these practices; among them the ASTM publication #06-520077-40 "Standards of Thermocouples, 1978" and the Instrument Society of America publication "American National Standard for Temperature Measurement Thermocouples, MC96.1, 1975."

Immediate Delivery

Ordering Information

Part Number	Materials	ANSI Type	50 feet of:	Wire Diameters .001	.002	.003	.005	.010	.015
KIT-E	Nickel-Chromium (Chromel)	EP		X	X	X	X	X	X
	and Copper-Nickel (Constantan)	EN		X	X	X	X	X	X
KIT-J	Iron	JP		X	X	X	X	X	X
	and Copper-Nickel (SAMA Constantan)	JN		X	X	X	X	X	X
KIT-K	Nickel-Chromium (Chromel)	KP		X	X	X	X	X	X
	and Nickel-Aluminum (Alumel)	KN		X	X	X	X	X	X
KIT-T	Copper	TP		X	X	X	X	X	X
	and Copper-Nickel (Constantan)	TN		X	X	X	X	X	X

FINE GAUGE, BARE THERMOCOUPLE WIRE

Protective cover mechanically protects wire, prevents wire snags, may be handled with ease!

High quality, bare thermocouple wire is available in matched spools of six different calibrations. To ensure that the user will be able to produce high quality thermocouples, Thermometrics sells only matched pairs of thermocouple wire on 50 foot (each) spools. Only by using matched pairs of thermocouple wire can the user manufacture a thermocouple that will conform to the ANSI "Standard Limits of Error for Thermocouples" as defined in their publication MC96.1, 1975.

Each component element is sold in continuous* 50 foot lengths on our unique spools equipped with a snap on cover that keeps out dust and prevents wire snags.

*.001" diameter may have random lengths not less than 15 feet.

Ordering Information

ANSI Type	Wire Components positive wire listed first	Part Number	Wire Diameter
E	Nickel-Chromium (Chromel) and Copper-Nickel (Constantan)	E-001-2SP	0.001
		E-002-2SP	0.002
		E-003-2SP	0.003
		E-005-2SP	0.005
		E-010-2SP	0.010
		E-015-2SP	0.015
		E-020-2SP	0.020
		E-032-2SP	0.032
J	Iron and Copper-Nickel (SAMA Constantan)	J-001-2SP	0.001
		J-002-2SP	0.002
		J-003-2SP	0.003
		J-005-2SP	0.005
		J-010-2SP	0.010
		J-015-2SP	0.015
		J-020-2SP	0.020
		J-032-2SP	0.032
K	Nickel-Chromium (Chromel) and Nickel-Aluminum (Alumel)	K-001-2SP	0.001
		K-002-2SP	0.002
		K-003-2SP	0.003
		K-005-2SP	0.005
		K-010-2SP	0.010
		K-015-2SP	0.015
		K-020-2SP	0.020
		K-032-2SP	0.032
R	Platinum 13% Rhodium and Platinum	R-001-2SP	0.001
		R-002-2SP	0.002
		R-003-2SP	0.003
		R-005-2SP	0.005
		R-008-2SP	0.008
		R-010-2SP	0.010
		R-015-2SP	0.015
		R-020-2SP	0.020
		R-032-2SP	0.032
S	Platinum 10% Rhodium and Platinum	S-001-2SP	0.001
		S-002-2SP	0.002
		S-003-2SP	0.003
		S-005-2SP	0.005
		S-008-2SP	0.008
		S-010-2SP	0.010
		S-015-2SP	0.015
		S-020-2SP	0.020
		S-032-2SP	0.032
T	Copper and Copper-Nickel (Adams Constantan)	T-001-2SP	0.001
		T-002-2SP	0.002
		T-003-2SP	0.003
		T-005-2SP	0.005
		T-010-2SP	0.010
		T-015-2SP	0.015
		T-020-2SP	0.020
		T-032-2SP	0.032

TERMS AND CONDITIONS

All items are shipped from inventory, F.O.B. Edison, New Jersey. Terms are Net 30 days to customers who have established credit. Those customers who have not established an open account are requested to submit payments in full with their order. C.O.D. orders are also accepted.

Production quantities of thermocouples are available to manufacturers at O.E.M. pricing. Consult factory for details. Special sizes, and/or alloys are also available; contact factory for price quotation and delivery time.

THERMOMETRICS INC.
808 U.S. HIGHWAY 1, EDISON, N.J. 08817
PHONE: (201) 287-2870

THERMOMETRICS INC.

The Source of Thermistor Expertise

DIGITAL THERMOMETER

MODEL 866

Thermometrics, Inc. Model 866 Digital Thermometers offer high accuracy over a range of -55 to 150° C, making them well suited for electronics, life sciences, food processing, HVAC and lab applications. The Model 866 Thermometer provides ruggedness and precision in a convenient compact size and at a comparatively low cost. The rugged double-wall case protects the unit from shock, moisture and dirt. Also available are a variety of sensor types all based upon Thermometrics precision interchangeable 2252 ohm thermistors. The Probe/Sensor is not included in base price. Choose the appropriate style from our Series DT866 Thermometer Probes.

SPECIFICATIONS:

Instrument Range: -55 to 150° C.

Instrument Accuracy: ±0.3% of reading (18 to 28° C ambient for one year).

Instrument Temperature Coefficient: less than + (0.06% reading + 0.01° C)/° C outside of stated accuracy range.

Sensor: Thermometrics Series DT866 Thermometer Probes (2252 ohms @ 25° C). Available in a variety of mountings and enclosures.

Sensor Accuracy: ±0.1 or ±0.2° C (0 to 70° C).

Mating Connection: 1/4" phone jack.

Display: 3½ digit LCD, 0.5" (13 mm) height. Polarity, decimal point, open sensor and overrange indication.

Reading Rate: 1.5 readings per second.

Battery Life: 350 hours typical, with 9V alkaline battery.

Battery Indicator: Display reads "LO BAT" when less than 10% of life remains.

Environmental Limits: Operation: -10 to 50° C.
Storage: -35 to 60° C.

Maximum Common Mode Voltage: 42 V peak.

Dimensions: Height 6.3" (160 mm) x Width 2.7" (69 mm) x Depth 1.2" (31mm).

Net Weight: 7.5 oz. (210 grams).

Accessories Supplied: Battery, manual.

Optional Accessories: Soft carrying case, Tilt Stand/Belt Clip

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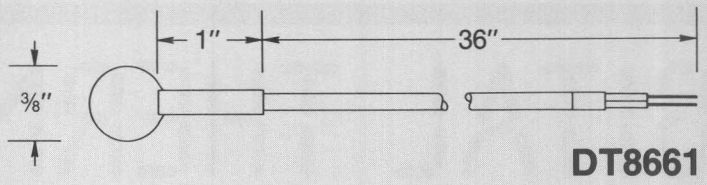
DT8661
Surface Sensor
Stainless steel cup, ⅜" diameter with 1" long shank, 2 conductor, 24 gauge cable with PVC outer jacket 36" long.



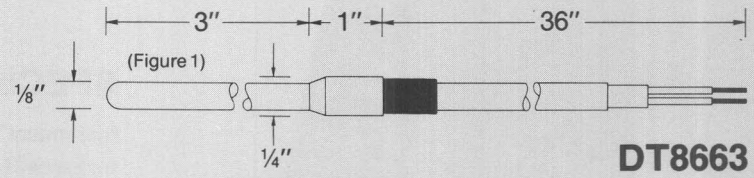
DT8661

DT8662
General Purpose Sensor
Molded plastic tip .080" diameter by ⅜" long, 2 conductor 30 gauge bifilar wire with PVC insulation 36" long.

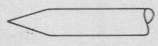
DT8662

DT8663 Immersion Sensor
Stainless steel tube ⅛" diameter by 3" long, 2 conductor 24 gauge shielded cable with PVC outer jacket 36" long (Figure 1).

DT8664 Penetration Probe
Stainless steel tube ⅛" diameter by 3" long pointed tip for penetration, 2 conductor, 24 gauge shielded cable with PVC outer jacket 36" long (Figure 2).

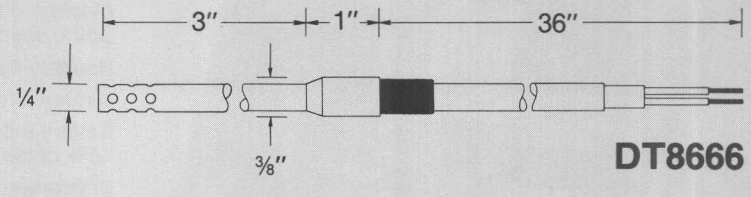


DT8663



DT8664 Penetration Probe (Figure 2)

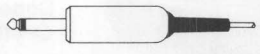
DT8666
Air/Gas Sensor
Stainless Steel tube ¼" diameter by 3" long with thermistor suspended in air with no contact to sides of tube for rapid response, 2 conductor 24 gauge shielded cable with PVC outer jacket 36" long.



DT8666

SENSOR FACTS

* Nominal 2252 ohms at 25°C.
* ±.2°C from 0-70°C.

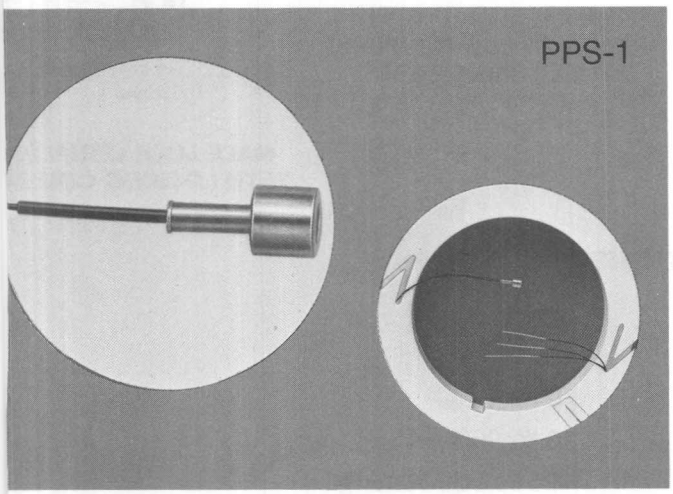


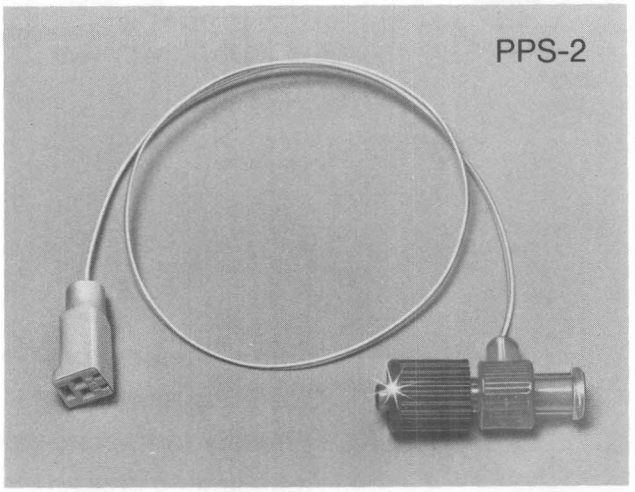
* Supplied with ¼" phone plug.

ALL ABOVE SENSORS ARE RATED TO 70°C. FOR TEMPERATURES ABOVE 70°C, CONSULT FACTORY.
AFTER PART NUMBER USE SUFFIX V FOR ±0.1°C.
AFTER PART NUMBER USE SUFFIX W FOR ±0.2°C.

physiological pressure sensors

for Medical Research & Clinical Use





ermometrics, Inc. is a leading manufacturer of disposable electronic nponents and assemblies for the medical field. After many years in velopment THM has produced a small, accurate, low priced, disposable ssure transducer, suitable for laboratory, and biomedical use.

o design configurations are available: The PPS-1 design offers a distal tip unt for attachment to a seven (7) french catheter tube. The sensitive cone rubber diaphragm is at the front face, with the rear section serving as hank to attach to the catheter. Three-wire flexible insulated electrical ductors, six feet (6') long are provided for the manufacture of catheters of st lengths. The rear shank is tubular and acts as an atmospheric pressure erence.

e PPS-2 design has the exact technical specifications as the PPS-1 units ept that the unit is mounted into a disposable "T" fitting with luer tapers l locks at each end. The electrical connections are made through a nnector housing which includes the compensating and trim resistors as ll as the atmosphere pressure reference. This configuration is suitable for racorporeal fluid pressure measurement applications.

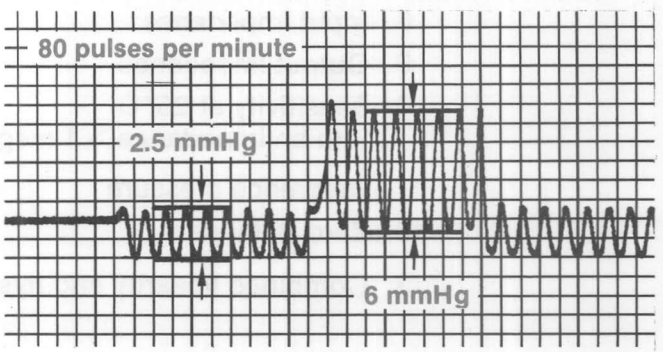
e THM PPS units incorporate a special configuration strain gauge that anges its electrical resistance as a function of pressure. The pressure nal is compatible with most DC amplifiers. Resistors are matched to each sor so that all sensors are both interchangeable as well as temperature npensated. The PPS units are provided as a full bridge circuit for use with sting instrumentation for making pressure movements.

PLICATIONS: The PPS-1 is designed for invasive use in measuring ssure at selected anatomical sites and more specifically for use in thermal ution catheters and wedge pressure catheters. It may also be used for n-invasive applications.

e PPS-2 is designed for extracorporeal applications such as intravenous od pressure monitoring and fluid line pressure monitoring.

e unique features of the Thermometrics PPS-1 and PPS-2 physiological ssure sensors are small size, high sensitivity, high accuracy, high stability d low cost.

ermometrics solicits customer inquiries for special applications.



Typical dynamic pressure signals

THERMOMETRICS INC.

U.S. PATENT NO. 4,554,927

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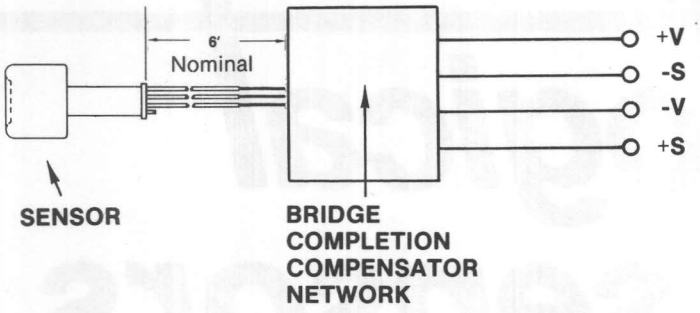
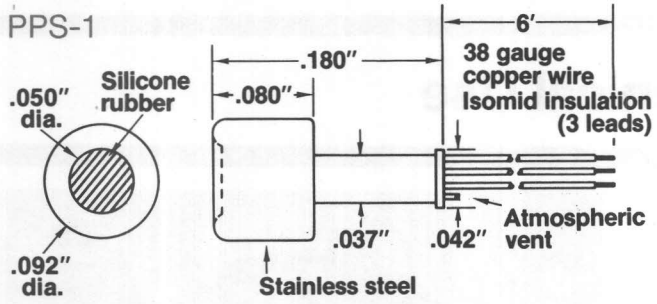


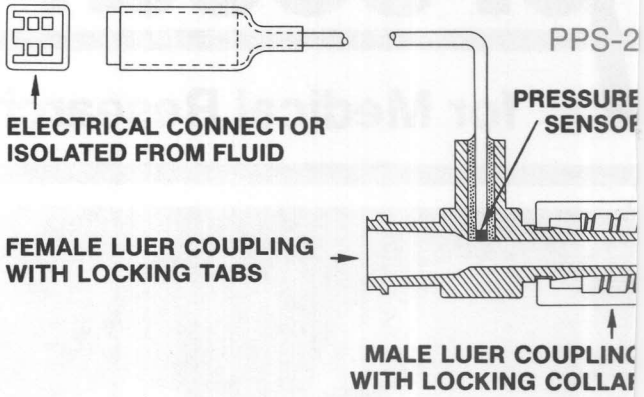
physiological pressure sensors

for Medical Research & Clinical Use

PPS-1



PPS-2



SPECIFICATIONS

1.	Storage temperature	-25 to 70° C
2.	Operating temperature	15 to 40° C
3.	Humidity (non-condensing)	10 to 95% RH
4.	Atmospheric pressure	425 to 850 mmHg
5.	Pressure range	-10 to 300 mmHg
6.	Over pressure	-100 to 1200 mmHg
7.	Excitation voltage	5 to 10 V DC
8.	Input impedance	500 ohms minimum
9.	Output impedance	500 ohms maximum
10.	Sensitivity at 25° C into an impedance > 1 megohm	5 microvolts per volt per mmHg
11.	Reference pressure	Atmosphere
12.	Zero Balance	< ±75 mmHg
13.	Combined linearity and hysteresis	± 2 mmHg 0 to 100 mmHg
14.	Risk current with 120V, 60 Hz applied between fluid and case, exposed metal, and all leads connected together.	< 10 microamps
15.	Zero drift with temperature	< .3 mmHg per °C
16.	Zero drift with time	< 3.0 mmHg per 24 hrs.
17.	Transducer in vivo life	72 hrs.

NOTE: Units supplied with external compensating network.

THERMOMETRICS INC.

RESISTANCE - TEMPERATURE CHARACTERISTICS